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NATIONAL DAM SAFETY PROGRAM. EHRLICH LAKE DAM (MO 10993), MISSI--ETC(U)
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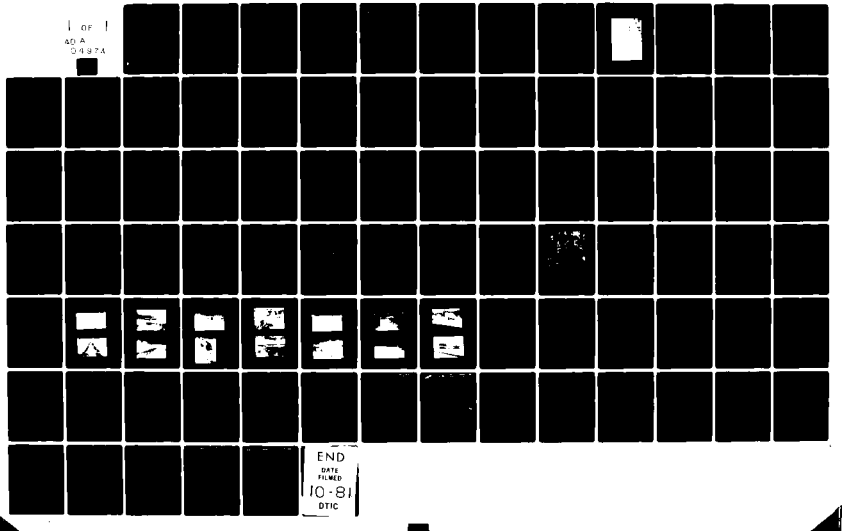

LEVEL II

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MISSISSIPPI·SALT·QUINCY RIVER BASIN

EHRLICH LAKE DAM
MONTGOMERY COUNTY, MISSOURI
MO. 10993

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER 1980

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 6310.

REPLY TO
ATTENTION OF

SUBJECT: Ehrlich Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Ehrlich Lake Dam (MO 10993).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

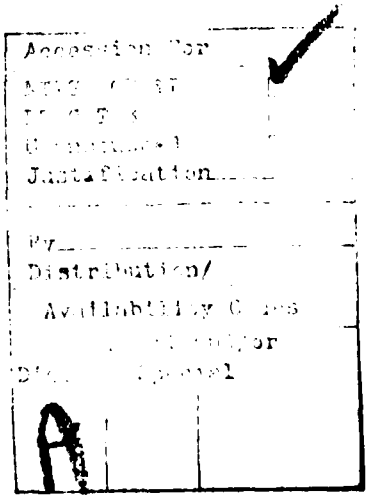
a. The combined spillway capacity will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 06 JAN 1981 — Date

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 06 JAN 1981 — Date



EHRLICH LAKE DAM
MONTGOMERY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10993

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

DECEMBER 1980

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Ehrlich Lake Dam, Missouri Inv. No. 10993
State Located: Missouri
County Located: Montgomery
Stream: An unnamed tributary of Coon Creek
Date of Inspection: July 8, 1980

Assessment of General Condition

Ehrlich Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. of St. Louis, Missouri and PRC Engineering Consultants, Inc. of Englewood, Colorado (A Joint Venture) according to the U. S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Within the estimated damage zone of one mile downstream of the dam are three dwellings, a church, and two trailers, which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Ehrlich Lake Dam is in the small size classification since it is 20 feet high, and impounds more than 50 acre-feet but less than 1,000 acre-feet of water.

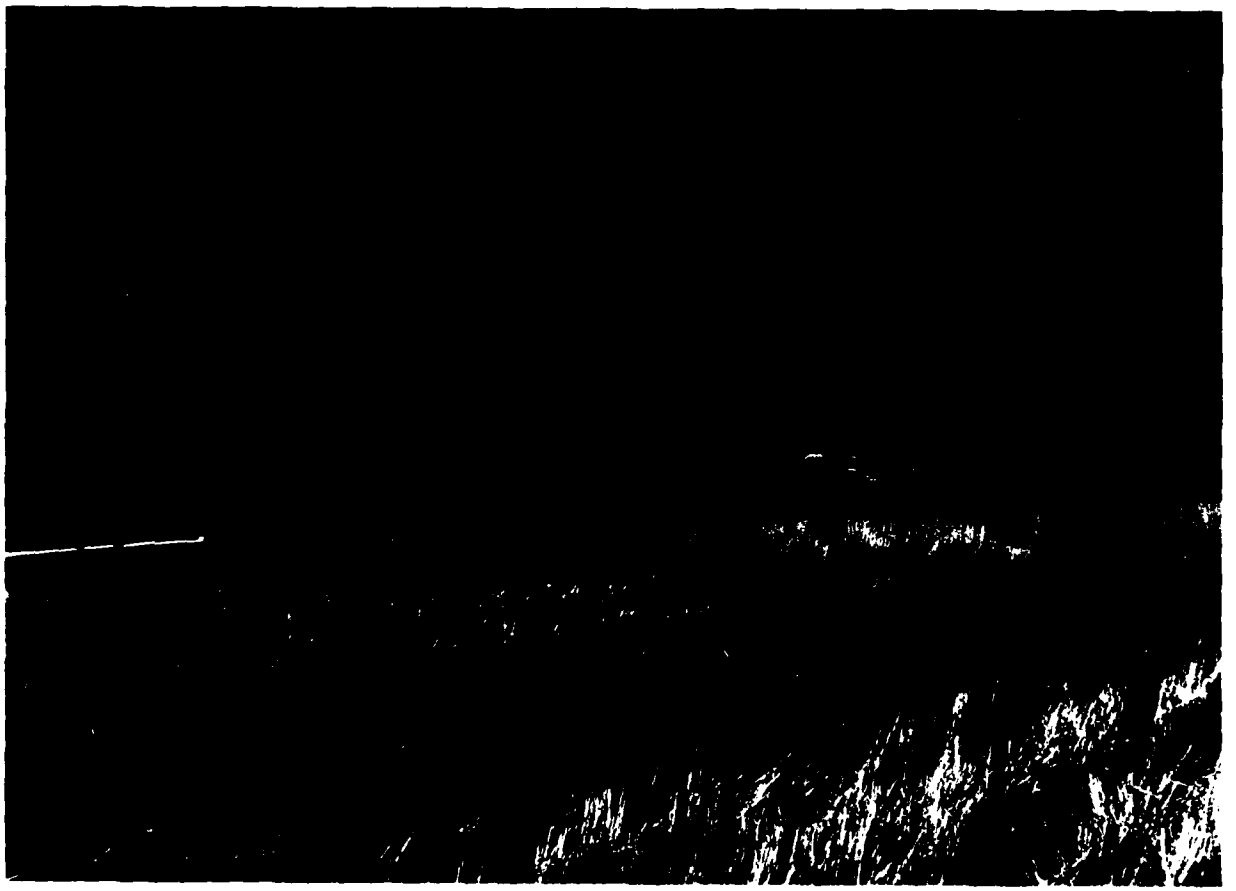
The inspection and evaluation by the consultant's inspection team indicates that the spillway of Ehrlich Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Ehrlich Lake Dam being a small size dam with a high

hazard potential is required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping the dam. Considering the number of inhabited dwellings located downstream of the dam and the relatively narrow valley downstream of the dam, the PMF is considered the appropriate spillway design flood for Ehrlich Lake Dam. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. It was determined that the reservoir/spillway system can accommodate approximately 14 percent of the Probable Maximum Flood without overtopping the dam. The evaluation also indicates that the reservoir/spillway system can not accommodate the one-percent chance flood (100-year flood) without overtopping; however, the reservoir/spillway system can accommodate the ten-percent chance flood (10-year flood) without overtopping the dam.

Other deficiencies noted by the inspection team were: the wave wash and minor surface runoff erosion on the upstream slope, the vegetative growth on the downstream slope, minor damage to the top of dam due to vehicular traffic, settlement of the top of dam over the principal spillway pipe, the erosion below and around the outlet of the principal spillway pipe, a need for periodic inspection by a qualified engineer and a lack of maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.



Overview - Carlton Lake Dam

NATIONAL DAM SAFETY PROGRAM

EHRLICH LAKE DAM, I.D. No. 10993

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

EHRLICH LAKE DAM, Missouri Inv. No. 10993

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Ehrlich Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., of St. Louis, Missouri and PRC Engineering Consultants, Inc. of Englewood, Colorado (A Joint Venture),

b. Purpose of Inspection

The visual inspection of Ehrlich Lake Dam was made on July 8, 1980. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site, and the structural adequacy of the various project features and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the northeast abutment or side, and right abutment or right side of the dam to the southwest abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

It should be noted that neither design drawings nor "as-built" drawings were available for the dam or appurtenant structures. The following description is based upon observations and measurements made during the visual inspection and conversations

with the original owner, Mr. Martin Leverett.

The dam embankment is a compacted earthfill structure with a curved alignment between natural soil abutments (see Photo Overview). The estimated radius of curvature is about 500 feet with circle center upstream. A plan and elevation of the dam are shown on Plate 2, and Photos 1 through 3 show views of the dam. According to information obtained from Mr. Leverett, the dam was designed by the Soil Conservation Service and is a homogeneous fill section with a central core trench. The core trench was 16-feet wide, from 18- to 20-feet deep, and excavated into a solid clay foundation. The embankment crest is 14 feet wide and serves as an access road for farm equipment. The top is generally level for a distance of 400 feet to the right of the left side of the embankment at which point the crest slopes upward to the right end of the dam with a rise in elevation of 1.25 feet. The top of the dam was measured to be 600 feet along the crest centerline between the two emergency spillways which bound the embankment. The minimum crest elevation is assumed to be at 721 feet above mean sea level (M.S.L.) and the maximum height of the embankment was measured to be about 20 feet.

The downstream slope of the embankment was measured as 1 vertical on 3.75 horizontal (1V on 3.75H) and the upstream slope was measured as 1V on 2.75H from the crest of the dam to the water surface. No erosion protection is provided in the upstream slope.

There are three spillways associated with this dam which are called, in this report, the principal spillway and the right and left emergency spillways.

The principal spillway consists of a drop inlet structure which is connected to a pipe that passes through the embankment and is located about 200 feet to the left of the right side of the dam (see Photo 5). The drop inlet is a 30-inch diameter steel pipe which stands about 34 inches high. The outlet pipe is an 18-inch diameter steel pipe approximately 110 feet long and laid through the

embankment on a grade of about 10 percent. The crest elevation of the drop inlet is at 717 feet above M.S.L. which puts the crest approximately 4 feet below the minimum top of dam. Discharges through the spillway drop approximately 5 to 6 feet into the downstream channel (see Photo 6). Two, 6-foot square, cutoff collars were provided along the outlet pipe, according to Mr. Leverett. A wire grate was also provided as a trashrack for the spillway.

The right emergency spillway is a V-shaped, uncontrolled, open channel located at the right side of the embankment (see Photo 8). The control section of the spillway has side slopes of approximately 1V on 11H on the left side of the channel and 1V on 15H on the right. The crest elevation of the spillway is at 719 feet above M.S.L. Flows through the control section of the spillway discharge down the right abutment area and along the toe of the dam until they intersect the downstream channel near the outlet of the principal spillway.

The left emergency spillway is also a V-shaped, uncontrolled, open channel (see Photo 9). The spillway is located at the left side of the embankment with side slopes of the control section of approximately 1V on 14H on the right side of the channel and 1V on 18H on the left. The elevation of the crest is at about 719.33 feet above M.S.L. Flows through the spillway also discharge down the abutment area and along the toe of the dam until they intersect the downstream channel near the outlet of the principal spillway. Both emergency spillways, according to Mr. Leverett, were cut into the placed embankment. Both emergency spillways have discharge channels which slope at approximately a 7 percent grade for a distance of 50 feet downstream of the crest and then they steepen as channels head toward the downstream channel.

No low level outlets or outlet works were provided for this dam. However, a portable, gasoline powered, 18-inch, centrifugal pump is used at the damsite (see Photo 11). The pump is used to pump water from the reservoir to be used to irrigate row crops on the reservoir rim. The pump is used only when irrigation water is required and is generally used during the summer months.

b. Location

Ehrlich Lake Dam is located in Montgomery County, Missouri, on an unnamed tributary to Coon Creek. The small community of Middletown is about one mile to the southeast. The Ehrlich Lake Dam location on the 7.5 minute series of the U.S. Geological Survey maps is found in Section 2 of Township 50 North, Range 5 West, of the Middletown Missouri Quadrangle Sheet.

c. Size Classification

The impoundment of Ehrlich Lake Dam is less than 1,000 acre-feet but more than 50-acre feet, and the height is 20 feet. Therefore, the size is determined to fall in the "small" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. The findings of the inspection team concur with this classification. Within the estimated damage zone, extending one mile downstream of the dam, are three dwellings, a church, and two trailers.

e. Ownership

Ehrlich Lake Dam is at present owned by Mr. Steve Ehrlich. His address is as follows: Route 2, Box 68, Middletown, Missouri, 63359. The dam was previously owned by Mr. Martin Leverett, also of Middletown, Missouri.

f. Purpose of Dam

The dam was constructed to impound water for crop irrigation.

g. Design and Construction History

Ehrlich Lake Dam was designed by the Soil Conservation Service of Montgomery County, Missouri, in 1975. According to Mr. O. Swanegan of the Soil Conservation Service, no design records or drawings were available for review for this report.

According to the original owner, Mr. Leverett, the dam was built by Mr. Leonard Thompson of Middletown, Missouri, and the Soil Conservation Service inspected the construction on several occasions. The drop inlet to the principal spillway was placed one year after the initial construction, according to Mr. Leverett, however, the spillway was originally designed as a drop inlet structure. Also according to Mr. Leverett, approximately 3 feet of soil was placed on the top of dam at the same time as the construction of the drop inlet.

h. Normal Operational Procedures

Normal operational procedure at Ehrlich Lake Dam is to allow water to remain as full as possible while the water level is controlled by rainfall, runoff, evaporation, the elevation of the principal spillway crest and the rate at which water is used for irrigation purposes.

1.3 Pertinent Data

a. Drainage Area (square miles):. 0.71

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): 29

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 401

c. Elevation (Feet above MSL)

Top of dam (minimum)*: 721

Spillway crest:

Principal Spillway 717

Left Emergency Spillway. 719.33

Right Emergency Spillway 719

Normal Pool: 717

Maximum Experienced Pool:. 719.33

Observed Pool: 717

d. Reservoir

Length of pool with water surface at top of dam elevation (feet):. 2,500

e. Storage (Acre-Feet)

Top of dam (minimum):. 191

Spillway crest:

Principal Spillway 99

Left Emergency Spillway 149

Right Emergency Spillway. 141

Normal Pool: 99

Maximum Experienced Pool:. 149

Observed Pool: 99

f. Reservoir Surfaces (Acres)

Top of dam (minimum):. 28

Spillway crest:	
Principal Spillway:	18.5
Left Emergency Spillway:	23.8
Right Emergency Spillway:	23
Normal Pool:	18.5
Maximum Experienced Pool:	23.8
Observed Pool:	18.5

g. Dam

Type:	Rolled, earthfill
Length:	600 feet
Structural Height:	20 feet
Hydraulic Height**:	20 feet
Top width:	14 feet
Side slopes:	
Downstream	1V on 3.75H
Upstream	1V on 2.75H
	(Above the water surface)
Zoning:	Homogeneous
Impervious core:	N.A.
Cutoff:	A 16-foot wide, core trench
Grout curtain:	None
Volume:	26,300 cu.yds. (estimated)

h. Diversion and Regulating Tunnel . . . None

i. Spillway

Type:	
Principal Spillway	Drop inlet, uncontrolled
Left Emergency Spillway.	Earthcut channel, uncontrolled
Right Emergency Spillway	Earthcut channel, uncontrolled

Length of crest:

Principal Spillway	7.9 feet (30-inch diameter standpipe with an 18-inch diameter connecting pipe)
Left Emergency Spillway	NA (triangular, shaped 53-foot top width)
Right Emergency Spillway	NA (triangular shaped, 86-foot top width)

Crest Elevation (feet above MSL):

Principal Spillway	717
Left Emergency Spillway	719.33
Right Emergency Spillway	719

* The elevation of top of dam was assumed from the U.S.G.S. Middletown, Missouri Quadrangle topographic map. The elevations of other features of the dam were obtained using this elevation and the field measurements.

** The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of dam or the maximum water surface if below the top of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

According to the present and the original owner of the dam, the Soil Conservation Service designed the dam in 1975. However, no plans or specifications were available for this report.

2.2 Construction

No data is available concerning the construction of the dam and appurtenant structures, however, information was obtained from Mr. Leverett concerning the construction of the dam.

According to Mr. Leverett, the compaction of the embankment was achieved by the activity of the earthmoving equipment across the embankment; no compaction control was employed and periodic inspections of the damsite during the construction of the dam were made by the Soil Conservation Service (no record of the visits were found). A core trench was excavated parallel to the dam axis but not into bedrock. The trench is 16-feet wide and from 18- to 20-feet deep

2.3 Operation

No operation records are available for Ehrlich Lake Dam.

2.4 Evaluation

a. Availability

The availability of engineering data is poor and consists only of State Geological Maps, U.S.G.S. Quadrangle sheets, and a published Soil Survey of Montgomery County from the Soil Conservation Service.

In addition, no pertinent data were available for review of hydrology, spillway capacity, or flood routing through the reservoir. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available.

b. Adequacy

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation, and construction data, but is based primarily on visual inspection, past performance history, and sound engineering judgement.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data are available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Ehrlich Lake Dam was made on July 8, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Dr. M.A. Samad	PRC Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Civil and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
Zoran Batchko	PRC Engineering Consultants, Inc.	Soils
Kevin J. Blume	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Steve Ehrlich	Owner	
Martin Leverett	Original Owner (spoken to away from damsite)	

Specific observations are discussed below.

b. Dam

The top of the dam which serves as an access road for farm equipment does not have adequate erosion protection. Some minor damage due to the vehicular traffic was observed. A small depression was observed on the crest at the point where the principal spillway pipe passes through the embankment which appears to be due to settlement of backfill placed in the pipe excavation (see Photo 2). No other settlements of the crest or cracks were observed. No significant deviation in the vertical or horizontal alignment was apparent, other than the curved alignment as originally constructed. According to Mr. Ehrlich, the dam has never been overtopped and no evidence indicating the contrary was observed.

The upstream slope has no riprap protection and consequently has been eroded in some areas by wave action (see Photo 1). Nearly vertical faces 1- to 2-feet high have been exposed. The dam material, where exposed, is a moderately plastic silty to sandy clay. In addition where vegetative cover on the slope is sparse, minor erosion of the embankment due to surface runoff has taken place. Erosion rivulets on the order of 1- to 2-inches wide and deep were observed.

The downstream face has a dense, waist high, vegetative cover which consequently hampered a comprehensive inspection. The cover showed two distinct types of growth. The majority of the vegetation was a mixture of tall grass, weeds, and wheat. In contrast, several small localized areas of lush green vegetation were also observed (see Photos 3 and 4). The contrasting plant growths are not thought to be attributable to seepage but rather due to differences in vegetation covering the slope. No seepage was observed on the embankment or downstream of the toe. No bulges, depressions or cracks that would indicate an instability in the embankment were apparent on either of the slopes.

Both abutments slope gently upward from the top of dam. No instabilities, seepage, or erosion were observed on either abutment.

No evidence of burrowing animals was apparent on either the embankment or abutments. Nevertheless, muskrats have been observed on the dam in the past according to Mr. Ehrlich.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of Coon Creek in the Dissected Till Plains Section of the central Lowland Physiographic Province. Loess-mantled Kansas drift covers the surface of most of the Dissected Till Plains Section. This section is distinguished from the Young Drift Section to the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain submature to mature in its erosion cycle.

The topography at the damsite is rolling with U-shaped valleys. Elevation ranges from 720 feet above M.S.L. at the damsite to 780 feet above M.S.L. approximately 1.0 mile northeast of the damsite. The reservoir slopes are in the range of 7^{o} from horizontal at the northern and western side, and in the range of 20^{o} from the horizontal at the southwestern side of the reservoir. The reservoir slopes appear to be stable. The area in the vicinity of the damsite is covered with slope wash of glacial-fluvial deposits and loess.

The regional bedrock geology beneath the glacial outwash deposits in the damsite area as shown on the Geologic Map of Missouri (1979), (see Plate 4), consist of Pennsylvanian Marmaton-Cherokee Group (cyclic deposits of shale, limestone, and sandstone), Mississippian age rocks (St. Genevieve Formation, St. Louis Forma-

tion, Salem Formation, Burlington Formation and Chateau Group rocks), Devonian age rocks (Sulphur Spring Group), Silurian Bowling Green Limestone, and Ordovician age rocks consisting of Maquoketa Shale, Decorah Formation, and St. Peter Sandstone. No outcropping of bedrock was observed at the site.

The predominent bedrock at the site vicinity underlying the glacial-fluvial deposits are the Pennsylvanian Marmaton-Cherokee Group (cyclic deposits of shale, limestone, and sandstone) and Mississippian Burlington Formation (brown, sandy, cherty limestone).

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Cap Au Gres Faulted flexure nearly 20 miles northeast of the dam. The Cap Au Gres Faulted flexure had its last movement in post-Pennsylvanian, pre-Pleistocene time. This fault appears to have no effect on the damsite.

Ehrlich Lake Dam consists of a homogeneous earthfill embankment, a drop inlet principal spillway with a metallic outlet pipe located at the maximum section of the embankment and two emergency spillways with one located at each end of the embankment.

No boring logs or construction reports were available that would indicate foundation conditions encountered during the construction. Based on the visual inspection and conversations with Mr. Leverett, the embankment probably rests on the glacial-fluvial deposits (mottled reddish brown to gray, silty clay) with a core trench excavated into the glacial-fluvial deposits. The two emergency spillways, according to Mr. Leverett, were cut through the embankment after the embankment was placed.

(2) Project Soils

According to the "Soil Survey of Montgomery and Warren Counties, Missouri" published by the Soil Conservation Service in 1978, the materials in the general area of the dam belong to the Armster Series of soils. The soils were basically formed from glacial till under prairie grasses. The permeability of these soils ranges from moderate to low. The Armster Loam is susceptible to erosion if unprotected by vegetative cover. It is unknown whether the Armster Loam was used in the embankment, however, if the soil type was indeed used, the potential of failure of the embankment would be increased due to erosion during overtopping.

Materials removed from the downstream slope at several locations was comparable to materials exposed on the upstream face of the embankment. The material removed from the embankment was a light brown to mottled reddish brown, moderately plastic, silty- to sandy-clay. Based on the Unified Soil Classification System, the soil would be classified as a ML-CL. This soil type generally has the following characteristics: semipervious to impervious with a coefficient of permeability less than 100 feet per year, medium shear strength and low to intermediate resistance to piping and erosion.

d. Appurtenant Structures

(1) Principal Spillway

The trashrack provided for the spillway appears to be functioning the way it was intended. On the day of the inspection, some debris was observed on the top of the trashrack (see Photo 5). The trashrack, however, did not appear to be securely attached to the drop inlet. The spillway pipes do not appear to be obstructed due to the fact that the reservoir level on the day of the inspection was slightly above the spillway crest and water was observed discharging from the outlet end of the pipe. No seepage was ob-

served around the outlet pipe. The drop inlet structure appeared to be structurally stable. Some minor surface rusting of the outlet pipe was observed. Considerable erosion has occurred around the outlet of the spillway due to surface runoff and/or discharges through the spillway (see Photo 6). The erosion has formed near vertical scarps near the pipe and appears to be progressing back into the embankment.

(2) Emergency Spillways

The emergency spillways supported, for the most part, an adequate vegetative cover except for where the access road across the dam travels through the spillways (see Photos 8 and 9). No erosion or instabilities were apparent in either spillway. Both spillways were unobstructed and appeared to be able to function properly.

(3) Outlet Works

There were no outlet works constructed for this dam. However, a portable, centrifugal pump is used at the damsite. According to Mr. Ehrlich, the pump is operable and may be used to drain the reservoir, if needed.

e. Reservoir Area

The reservoir water surface elevation at the time of inspection was 717 feet above M.S.L.

The surface area of the reservoir at normal water level is about 18.5 acres. The rim seems to be stable as no severely eroded areas were observed, with the exception of small scarps at the water surface. The land around the reservoir is farmed land with some wooded areas and slopes gently to the rim (see Photo 12). There are no homes built in close proximity to the reservoir.

f. Downstream Channel

The downstream channel which carries flows from the principal and emergency spillways is a well-defined channel. However, the channel is obstructed by heavy vegetation (see Photo 7) and is eroded just downstream of the principal spillway outlet. The channel is approximately 3 feet wide, 6 feet deep, and has a side slope of 1V on 2H on both sides.

3.2 Evaluation

The visual inspection did not exhibit any items which are sufficiently significant to indicate a need for immediate remedial action. The following conditions, however, were observed which could adversely affect the dam in the future.

1. Erosion by wave action on the upstream slope near the top of dam does not appear to affect the structural stability of the dam in its present condition. Nevertheless, continual erosion of the slope can only be detrimental to the stability of the dam.

2. The dense vegetation in areas of the upstream face and over the entire downstream face hinders the conduct of a comprehensive inspection which could allow potential problems to go undetected. The growth of vegetation on the embankment should be properly maintained.

3. Areas on the upstream face where vegetative cover is sparse are showing signs of erosion due to surface runoff, however, the erosion does not affect the safety of the dam at this time.

4. The top of the dam access road shows signs of erosion due to vehicular travel and has the potential to be further eroded by surface runoff.

5. The settlement of the top of dam over the principal spillway outlet pipe which appears to be due to settlement of the backfill placed around the pipe does not appear to be detrimental to the stability of the dam in its present condition.

6. The erosion observed near the outlet of the principal spillway does not appear to jeopardize the structural integrity of the dam and the principal spillway in its present condition. However, this condition should be attended to within a reasonable period of time to ensure the safety of the dam and spillway.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Erhlich Lake Dam was built to impound water for irrigation purposes and the owner, Mr. Steve Ehrlich, periodically pumps water from the reservoir to the surrounding cropland.

4.2 Maintenance of Dam

The dam and reservoir are maintained by the present owner, Mr. Steve Ehrlich. There is, at this time, no specific maintenance schedule for this dam. The top of dam serves as a farm access road. The slopes are clear of trees and bushes. Minor erosion was observed on the upstream slope due to wave action and surface runoff.

4.3 Maintenance of Operating Facilities

There are no operating facilities associated with this dam, except for the portable, centrifugal pump used at the site. The pump was located on the left side of the reservoir on the day of the inspection and is operable, according to Mr. Ehrlich.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system in use at the damsite.

4.5 Evaluation

The maintenance at Ehrlich Lake Dam appears to be inadequate. The remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

No hydrologic and hydraulic design data are available for Ehrlich Lake Dam. The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were based on the U.S.G.S. Middletown, Missouri Quadrangle topographic map (7.5 minute series). The spillway and overtop release rates and the reservoir elevation-area data are presented in Appendix B.

The hydrologic soil group of the watershed was determined from information available in the U.S.D.A. Soil Conservation Service publication "Missouri General Soil Map and Soil Association Descriptions", 1979. The Probable Maximum Precipitation (PMP) used to determine the Probable Maximum Flood (PMF) was determined by using the U.S. Weather Bureau publication "Hydrometeorological Report No. 33" (April 1956). The 100-year and the 10-year floods were derived from the 100-year rainfall and the 10-year rainfall respectively, of Warrenton, Missouri.

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site. However, according to the owner, the maximum reservoir level was approximately 4 inches above the crest of the right emergency spillway.

c. Visual Observations

Observations made of the spillways during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

Both the Probable Maximum Flood and one-half of the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The peak inflows of the PMF and one-half of the PMF are 6,258 cfs and 3,129 cfs, respectively. The peak outflow discharges for the PMF and one-half of the PMF are 5,822 and 2,820 cfs, respectively. The maximum capacity of the spillways just before overtopping the dam is 401 cfs. The PMF overtopped the dam by 1.92 feet and one-half of the PMF overtopped the dam by 1.15 feet. The total duration of flow over the dam is 6.67 hours during the occurrence of the PMF and 5.42 hours during one-half of the PMF. The spillway/reservoir system of Ehrlich Lake Dam is capable of accommodating a flood equal to approximately 14 percent of the PMF just before overtopping the dam. The reservoir/spillway system of Ehrlich Lake Dam will not accommodate the one-percent chance flood without overtopping; however, the reservoir/spillway system will accommodate the ten-percent chance flood without overtopping.

The surface soils on the embankment and in the emergency spillways appear to be silty clay. The emergency spillways have a good cover of grass; however, the top of dam does not have adequate protection against erosion. The dam will be overtopped by approximately two feet during the occurrence of the PMF which can cause severe erosion to the embankment due to the high velocity of flow on its downstream slope and could lead to an eventual failure of the dam. The maximum velocity of flow in the emergency spillways during the PMF will be about 7.5 ft/sec. The emergency spillway channels may also be subject to erosion due to high velocity of flow during the PMF.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately one mile downstream of the dam. Within the damage zone are three dwellings, a church, and two trailers.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection, except for the observed settlement of the top of dam over the principal spillway outlet pipe. The settlement is probably due to a lesser degree of compaction of the backfill around the pipe as compared to the compaction of other embankment material. The lesser compacted soil will be more susceptible to erosion than the other embanment soils. The settlement has also created a low point in the crest of the embankment that will concentrate flow when overtopping of the dam occurs. This could cause an early breach of the dam in area of the principal spillway and lead to a potential failure of the entire embankment. The apparent settlement of the backfill over the principal spillway pipe is not expected to increase beyond its present state. Nevertheless, it is felt that the condition should be monitored to ensure the stability and safety of the dam. Erosion of the upstream face due to wave action and surface runoff does not appear to affect the stability of the dam in its present condition. However, this condition could worsen and eventually severely affect the stability of the dam. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The spillways apparently appeared to be structurally stable on the day of the inspection. Nevertheless, the erosion around the outlet of the principal spillway, if allowed to continue, can only be detrimental to the stability of the dam and the principal spillway.

b. Design and Construction Data

Design computations pertaining to the embankment were not uncoverd during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records were available relating to the dam or appurtenant structures. The water level on the day of the visual inspection was approximately at the crest of the principal spillway. This is considered to be the normal operating level. The reservoir would normally be controlled by the level of the crest of the principal spillway.

d. Post Construction Changes

The addition of the drop inlet structure, one year after the construction of the dam and appurtenant structures, even though it raised the reservoir level about 34 inches, can not be considered a post construction change for the principal spillway was originally designed as a drop inlet type spillway. Three feet of soil was added to the top of dam, at the same time as the construction of the drop inlet. No other post construction changes to the embankment exist which will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1, as defined in "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude that would be expected in Seismic Zone 1 will not cause distress to a well-designed and constructed earth dam. Available literature indicates no active faults exist near the vicinity of the damsite.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The dam appears to be in poor physical condition. Also, the spillway capacity of Ehrlich Lake Dam is found to be "Seriously Inadequate". The spillway/reservoir system will accommodate approximately 14 percent of the PMF without overtopping the dam. The surface soils on the embankment and in the emergency spillways appear to be silty clay. The emergency spillways have a good cover of grass; however, the top of dam does not have adequate protection against erosion. The dam will be overtopped by approximately two feet during the occurrence of the PMF which can cause severe erosion

to the embankment due to the high velocity of flow on its downstream slope and could lead to an eventual failure of the dam. The maximum velocity of flow in the emergency spillways during the PMF will be about 7.5 ft/sec. The emergency spillway channels may also be subject to erosion due to high velocity of flow during the PMF.

A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment and appurtenant structures, however, reportedly have performed satisfactorily since their construction; there have been no failures or evidence of instability, except for the settlement of the top of dam over the principal spillway pipe. Reportedly, the dam has never been overtopped and no evidence indicating the contrary was observed. The safety of the dam can be improved if the deficiencies described in Section 3.2 and 6.1a are properly corrected as dsescribed in Section 7.2.

b. Adequacy of Information

The conclusions presented in this report are based upon field measurement, past performance, and the present condition of the dam. Information on the design hydrology, hydraulic design, and operation and maintenance of the dam were not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time, and the item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

One of the following mitigation measures should be undertaken to avoid severe consequences of dam failure from overtopping. These measures should be initiated under the guidance of an engineer experienced in the design and construction of earth dams.

1. Increase the spillway capacity to pass the Probable Maximum Flood without overtopping the dam.

2. Increase the height of the dam enough to pass the PMF without overtopping the dam; an investigation should also be done which includes studying the effects on the structural stability of the existing embankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

4. Provide a highly reliable flood warning system (generally does not prevent damage but avoids loss of life).

b. O & M Procedures

1. The wave and minor surface runoff erosion on the upstream slope should be properly repaired and the slope protected from further damage.

2. The vegetative growth on the downstream slope should be properly maintained and an adequate vegetative cover retained on the embankment to protect it from surface erosion. Large vegetation, such as trees and bushes should be prevented from growing on the embankment.

3. The top of the dam should be properly repaired and adequately protected so that further damage due to vehicular traffic does not occur and so that erosion due to surface runoff does not become a problem.

4. The settlement of the top of dam over the principal spillway outlet pipe should be monitored to ensure that the settlement is not due to an instability of the embankment or foundation. If the settlement does continue, proper measures should be undertaken to correct the situation. The depression caused by the settlement should be properly backfilled so that an early breach of the dam does not occur in this area due to overtopping of the dam.

5. The erosion observed near the outlet of the principal spillway pipe should be properly repaired and the area adequately protected to prevent further damage.

6. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

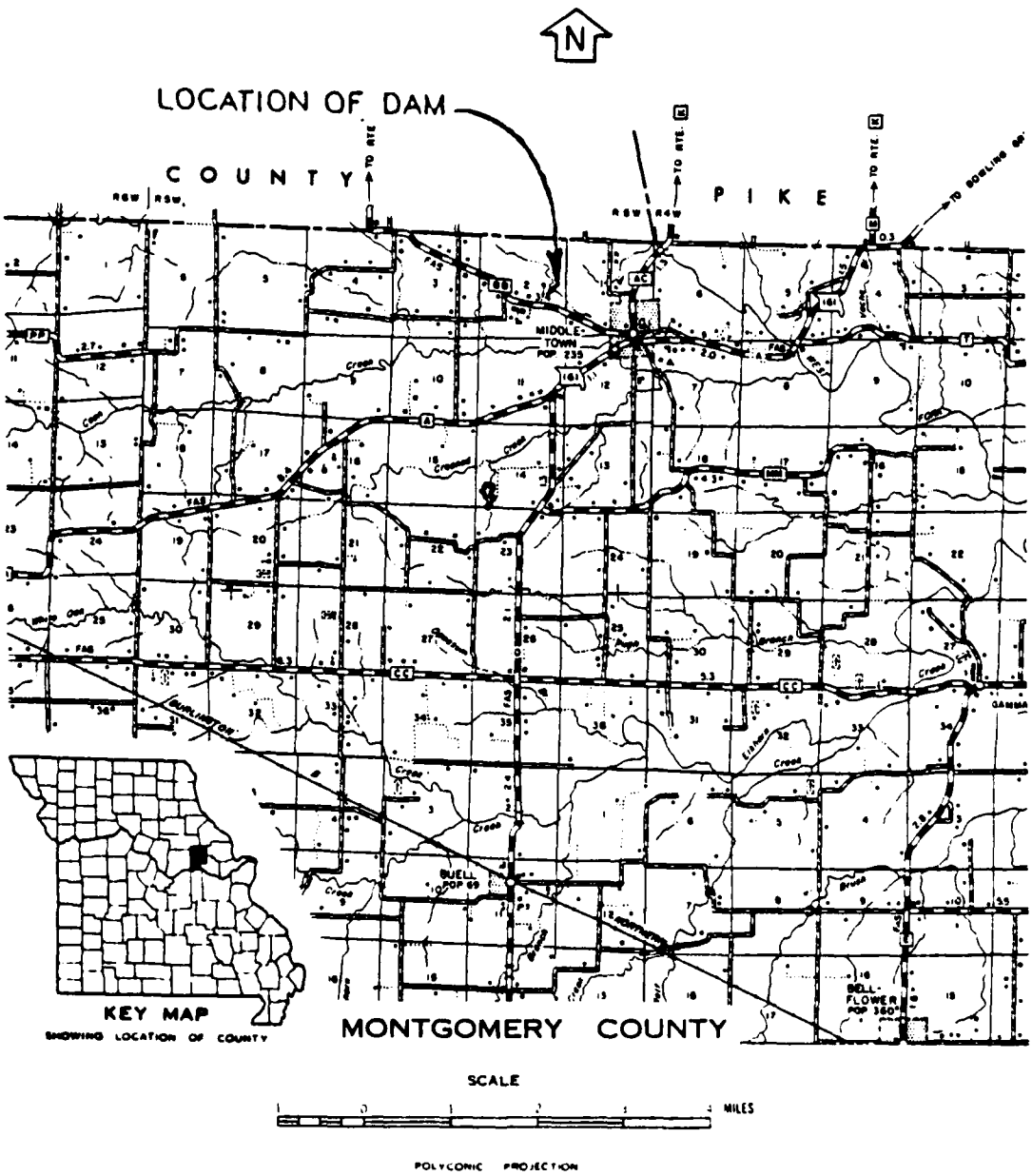
7. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

   (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs, and maintenance.

PLATES

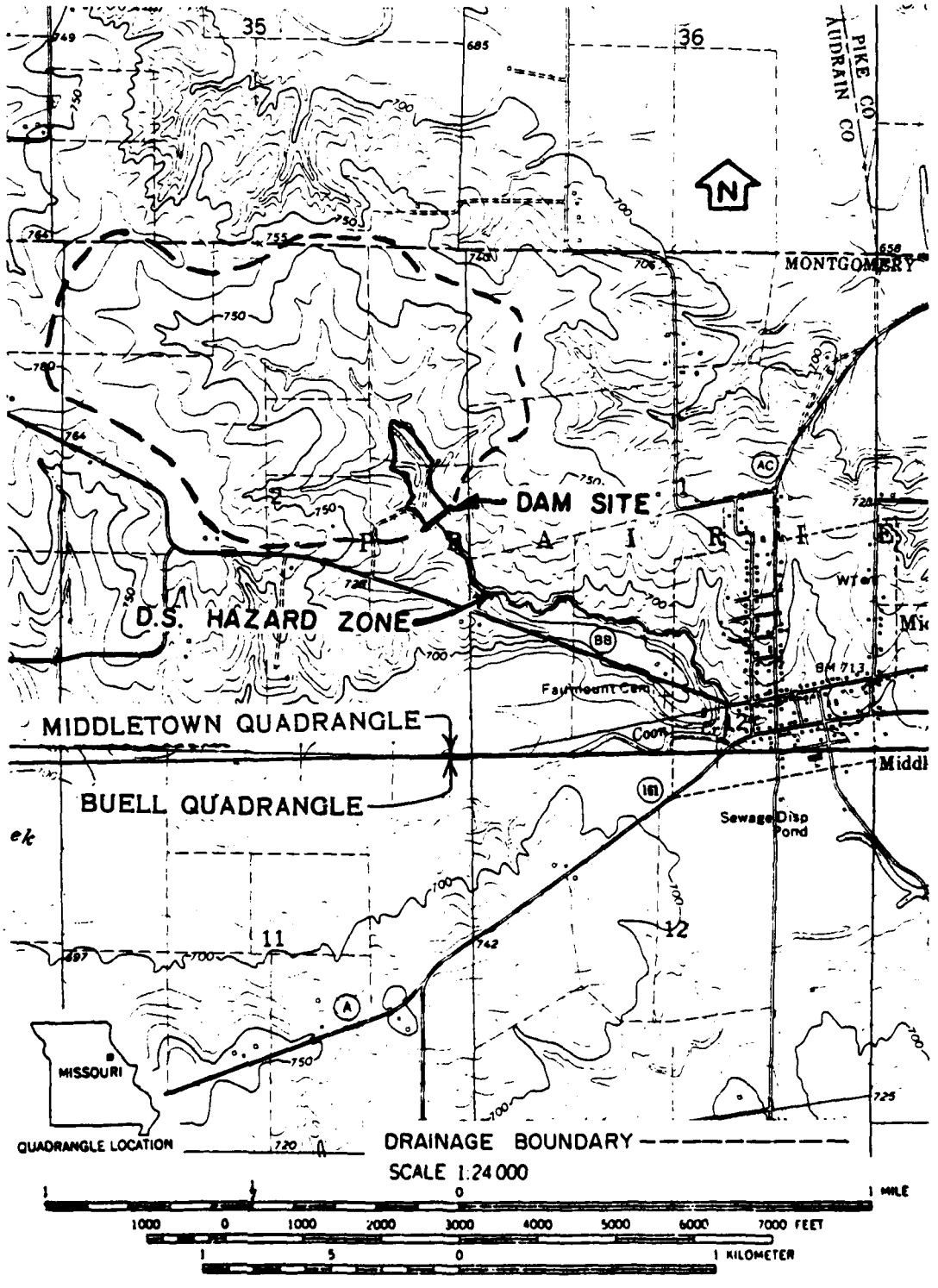
PLATE 1



LOCATION MAP - EHRLICH LAKE DAM

MO. 10993

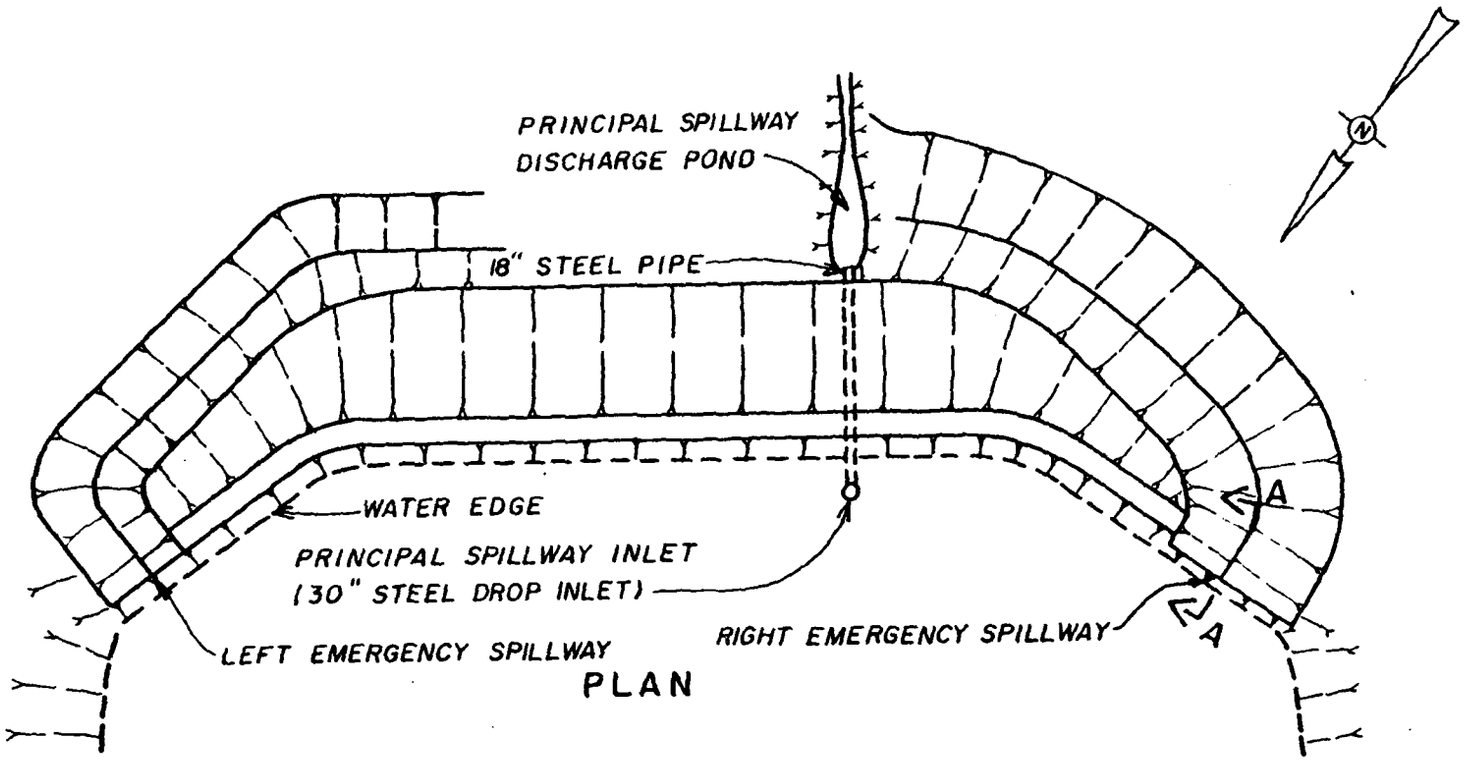
PLATE IA



EHRLICK LAKE DAM (MO. 10993)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE

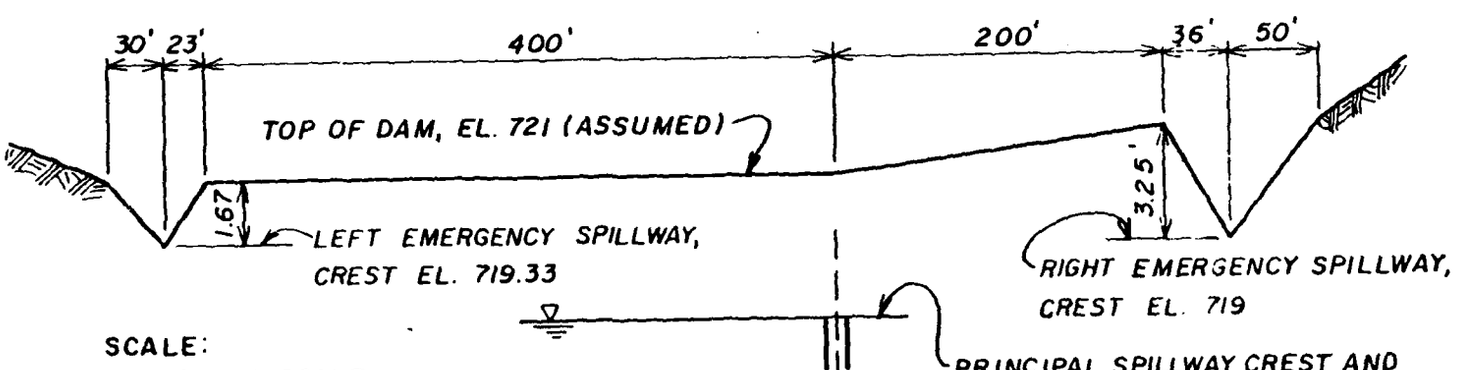
EHRLICH LAKE DAM (MO. 10993)
PLAN AND ELEVATION

NOTE:
ALL ELEVATIONS ARE SHOWN AS FEET ABOVE M.S.L.



PLAN

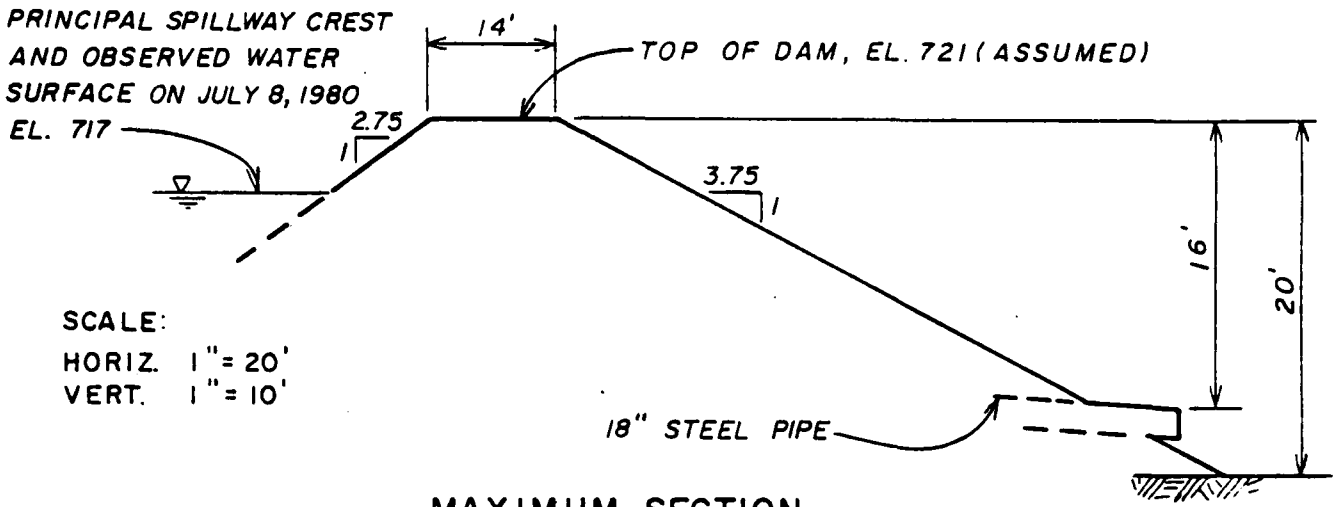
SCALE:
HORIZ. 1" = 100'



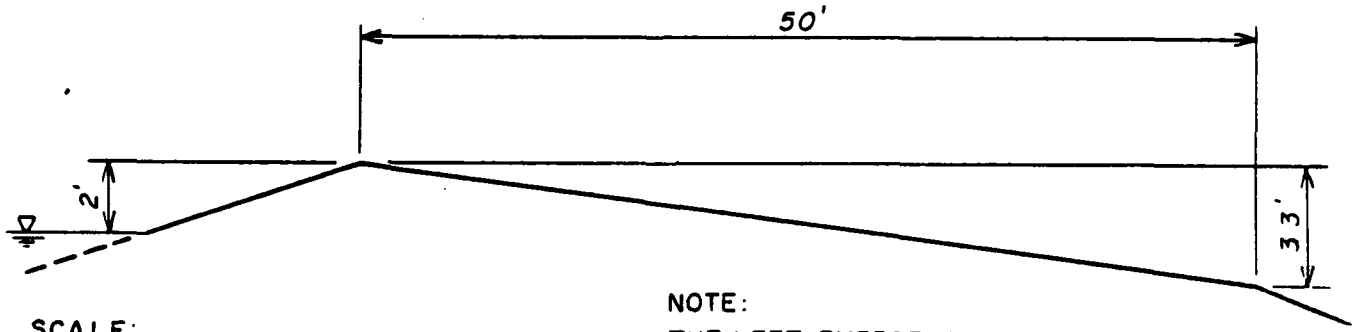
SCALE:
HORIZ. NO SCALE
VERT. 1" = 5'

ELEVATION

PLATE 2



MAXIMUM SECTION



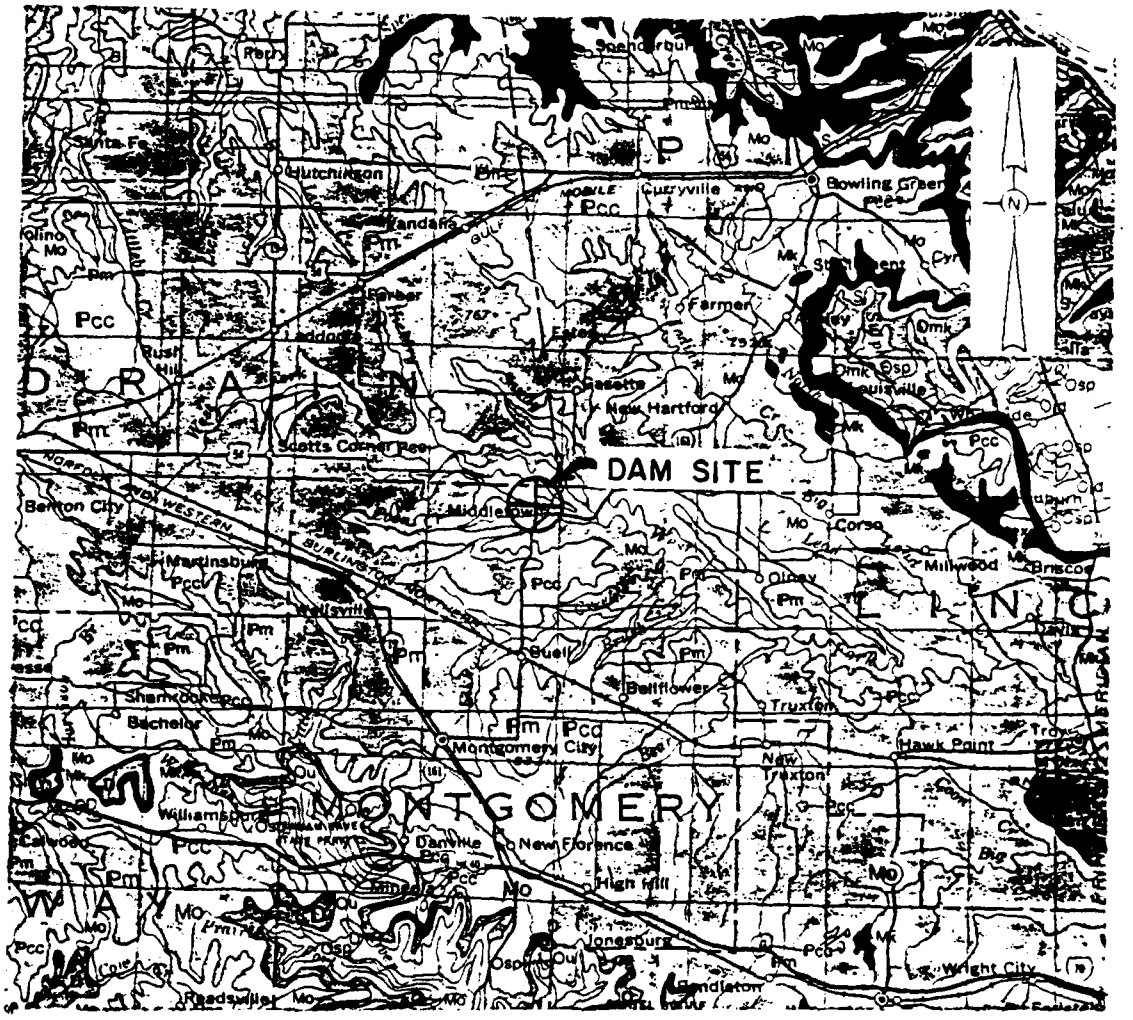
SCALE:
HORIZ. 1" = 10'
VERT. 1" = 5'

NOTE:
THE LEFT EMERGENCY SPILLWAY HAS APPROXIMATELY THE SAME PROFILE

SECTION A-A
(RIGHT EMERGENCY SPILLWAY PROFILE)

EHRLICH LAKE DAM (MO. 10993)
MAXIMUM SECTION OF EMBANKMENT
AND EMERGENCY SPILLWAY PROFILE

PLATE 4



SCALE

10 0 10 20 30 40 Miles

⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 5

REFERENCE:

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF EHRLICH LAKE DAM

EHRLICH LAKE DAM
PLATE 5

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mm	STE. GENEVIEVE: WHITE OOLITIC CLASTIC LIMESTONE ST. LOUIS: GRAY FINE GRAINED CRYSTALLINE LIMESTONE SALEM: GRAY FINE TO MEDIUM GRAINED ARGILLACEOUS LIMESTONE
	Mo	KEOKUK- BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	CHOUTEAU GROUP: HANNIBAL AND BACHELOR FORMATION (SANDSTONE, SHALE, CHERTY LIMESTONE AND SILTSTONE)
DEVONIAN	D	SULPHUR SPRING GROUP: BUSHBERG SANDSTONE, GLEN PARK LIMESTONE, GRASSY CREEK SHALE
SILURIAN	S	BOWLING GREEN LIMESTONE
ORDOVICIAN	Ou	NOIX LIMESTONE
	Omk	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE
	Osp	ST. PETER SANDSTONE

APPENDIX A

PHOTOGRAPHS

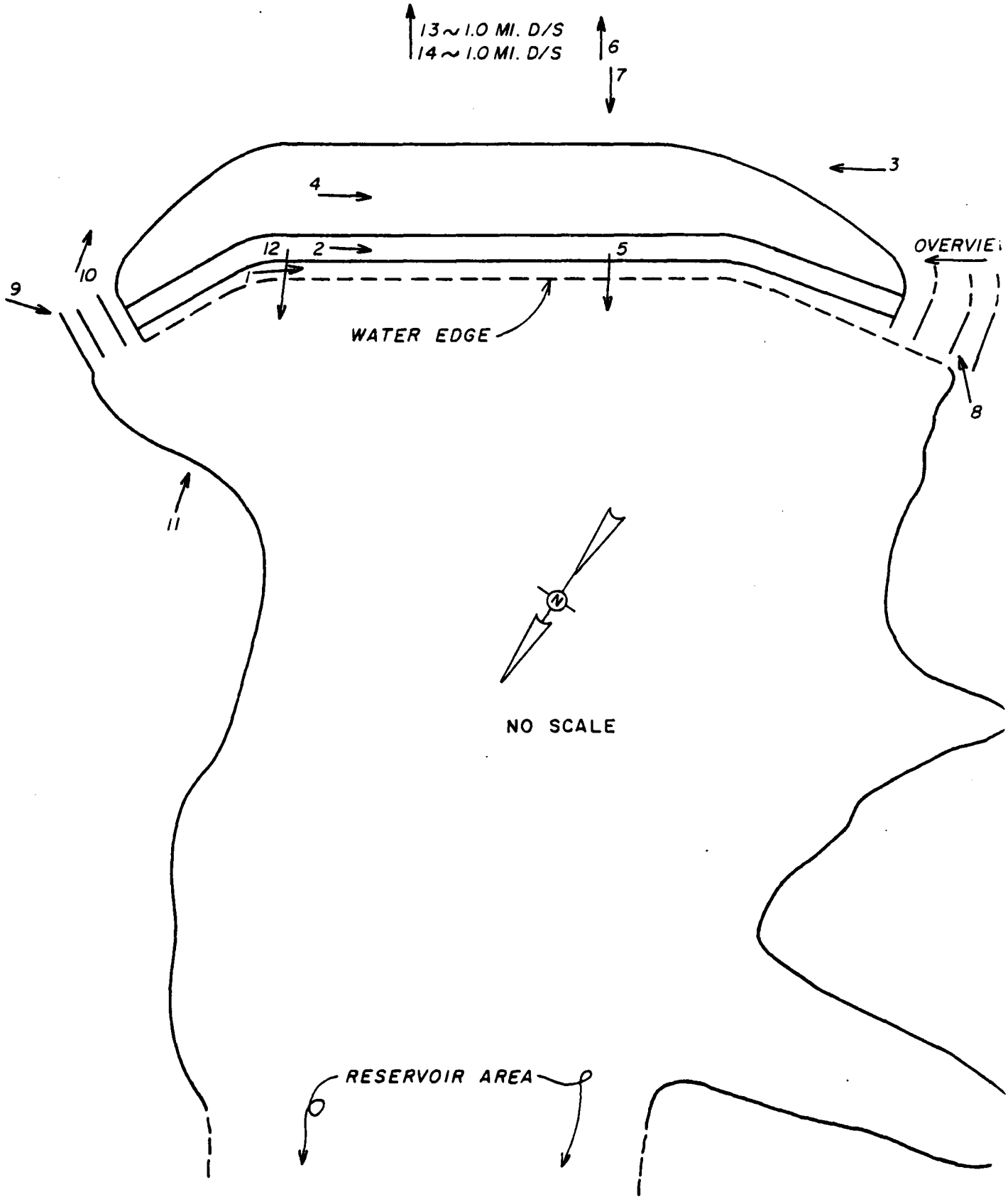


PHOTO INDEX
FOR
EHRLICH LAKE DAM

Ehrlich Lake Dam

Photographs

Photo 1 - View of the upstream slope from the left side of the embankment showing the wave erosion and vegetative cover.

Photo 2 - View of the top of dam showing the sparse vegetative cover and the settlement over the principal spillway outlet pipe.

Photo 3 - View of the downstream slope from the discharge channel of the right emergency spillway showing the unmaintained vegetative cover and the areas of lush, green vegetation.

Photo 4 - View of the downstream slope showing the areas of lush, green vegetation and the trees in the downstream channel.

Photo 5 - View of the inlet to the principal spillway showing the trashrack.

Photo 6 - View of the outlet of the principal spillway showing the erosion around the pipe.

Photo 7 - View of the downstream channel just downstream of the principal spillway pipe showing the obstruction of trees and bushes.

Photo 8 - View of the right emergency spillway looking downstream.

Photo 9 - View of the left emergency spillway looking back toward the reservoir.

Photo 10 - View of the left emergency spillway discharge channel with the dam embankment on the right side of the photo.

Photo 11 - View of the portable centrifugal pump used at the dam site.

Photo 12 - View of the reservoir and rim.

Photo 13 - View of a dwelling downstream of the dam that appears to be in the downstream hazard zone.

Photo 14 - View of a dwelling downstream of the dam that appears to be in the downstream hazard zone.

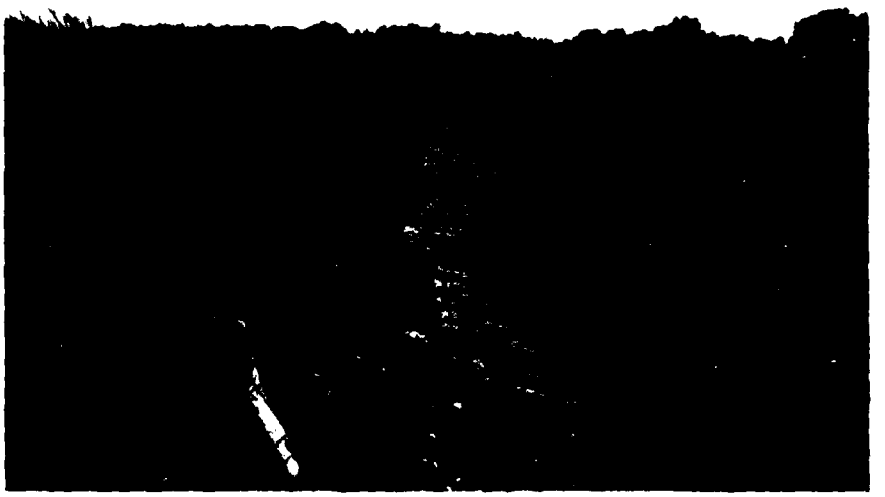


Photo 1

Photo 2

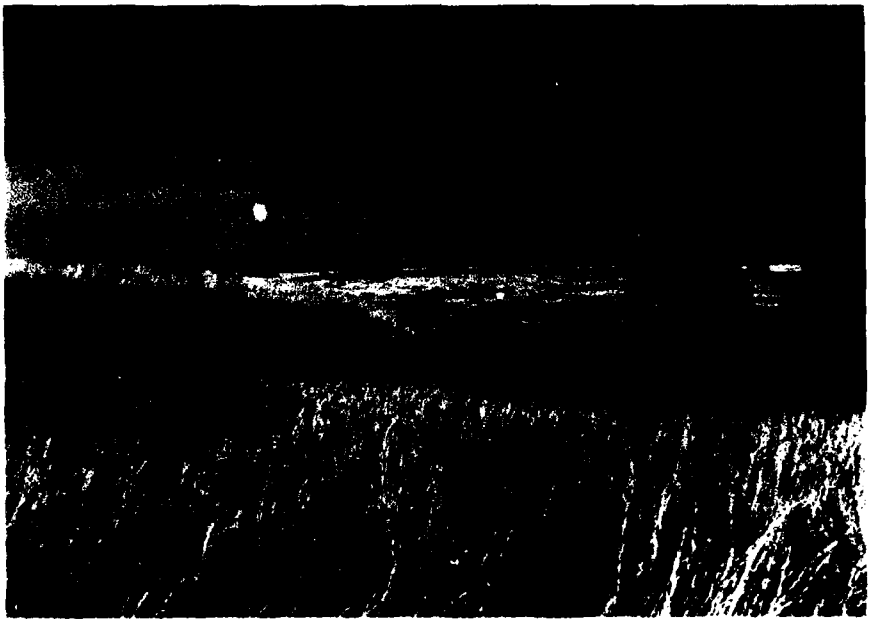


Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

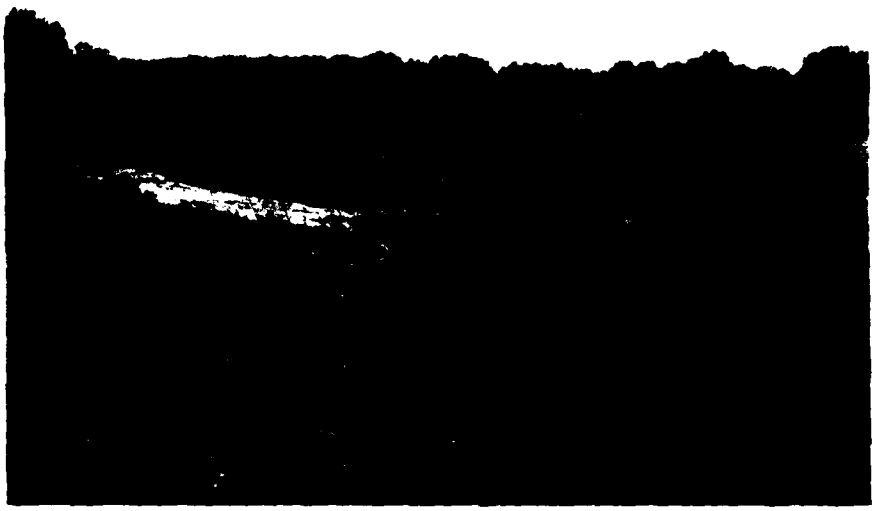


Photo 9

Photo 10

Photo 11

Photo 12

Photo 13

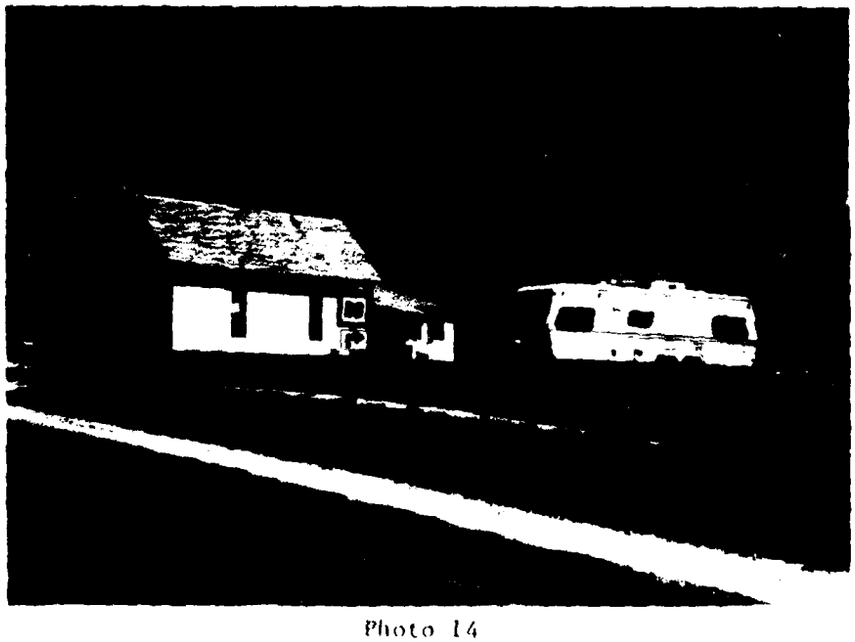


Photo 14

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

EHRLICH LAKE DAM

HYDROLOGIC AND HYDRAULIC DATA, ASSUMPTIONS AND METHODOLOGY

1. SCS Unit Hydrograph and HEC-1DB are used to develop the inflow hydrographs, and the hydrologic inputs are as follows:

   (a) Twenty-four hour probable maximum precipitation from Hydrometeorological Report No. 33, 24-hour 100-year rainfall and 24-hour 10-year rainfall of Warrenton, Missouri.

   (b) Drainage area = 0.71 square miles.

   (c) Lag time = 0.31 hours.

   (d) Hydrologic Soil Group:
   Soil Group "D".

   (e) Runoff curve number:
   CN = 83 for AMC II and CN = 93 for AMC III.

2. Flow rates through the two emergency spillways are based on critical depth assumption. Flow rates through the principal spillway are based on weir and pipe flow depending upon the stage in the reservoir. Flow rates over the dam are based on broad crested weir equation $Q = CLH^{3/2}$.

3. Floods are routed through Ehrlich Lake to determine the capability of its spillways.

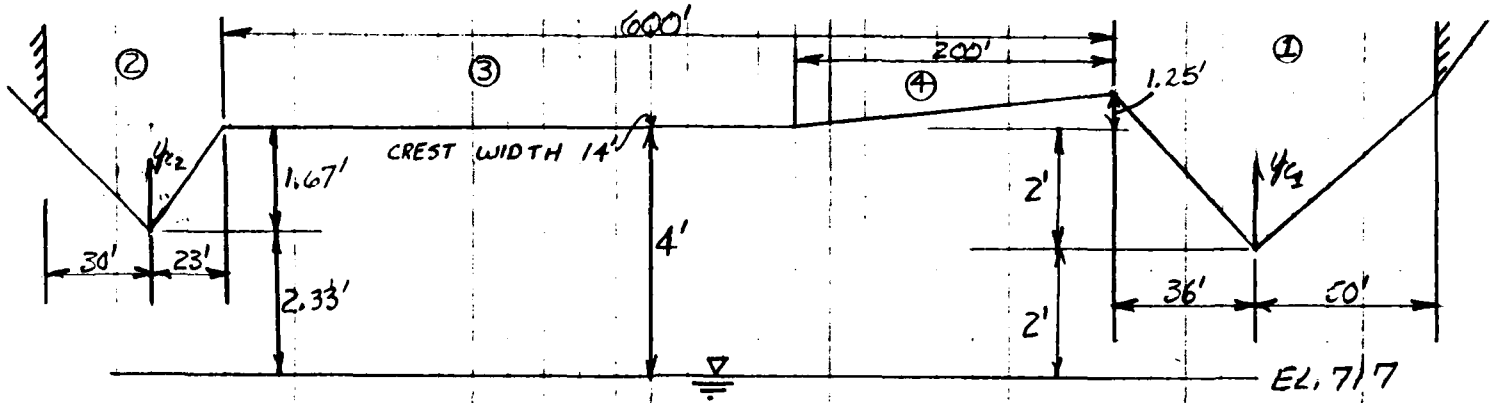
EC1-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SHEET INSPECTION / MISSOURI 1980 SHEET NO. 1 OF

EMRICH LAKE DAM (MO. 10995) JOB NO. 1263

EMERGENCY SPILLWAY AND OVERTOP RATING CURVE BY RD DATE 7/15/80

B-3



AREA 1: $A_1 = 13.23 y_{c1}^2$; $T_1 = 26.46 y_{c1}$ for $y_{c1} < 3.25'$; For $y_{c1} > 3.25'$ $A_1 = 86 y_{c1} - 139.75$; $T = 86$

AREA 2: y_{c2} is found by iteration such that

$y_{c2} + V_2^2/2g + 719.4 = W.S.ELEV.$

$A_2 = 15.9 y_{c2}^2$; $T = 31.8 y_{c2}$ for $y_{c2} < 1.67'$; For $y_{c2} > 1.67'$ $A_2 = 53 y_{c2} - 44.17$; $T = 53$

y_{c1}	A_1	T_1	$V_1 = \left(\frac{A_1 g}{T_1}\right)^{1/2}$	$Q = V_1 A_1$	$V_1^2/2g$	W.S.ELEV. $y_{c1} + \frac{V_1^2}{2g} + 719.4$	y_{c2}	A_2	T_2	$V_2 = \left(\frac{A_2 g}{T_2}\right)^{1/2}$	$Q_2 = V_2 A_2$	$V_2^2/2g$	H_3	C_3	L_3	$Q_3 = C_3 L_3 H_3^{1.5}$	H_4/y_{c4}	A_4	T_4	$Q_4 = \left(\frac{A_4^3 g}{T_4}\right)^{1/2}$	$Q_{TOTAL} = Q_1 + Q_2 + Q_3 + Q_4$
0	0	0	—	—	—	719	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
.25	0.8	6.62	2.01	1.7	0.06	719.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
0.5	3.3	13.2	2.84	.9	0.13	719.6	.15	0.4	4.77	1.55	1	0.04	—	—	—	—	—	—	—	—	10
1	13.2	26.5	4.01	53	0.25	720.5	.9	12.9	28.6	3.81	49	0.23	—	—	—	—	—	—	—	—	102
1.5	29.8	39.7	4.91	146	0.38	720.9	1.2	22.9	38.2	4.40	101	0.30	—	—	—	—	—	—	—	—	247
2	52.9	52.9	5.67	300	0.50	721.5	1.7	45.9	53.0	5.28	243	0.43	0.5	3.02	400	427	.5/.4	12.8	64.0	32	1002
2.5	82.7	66.2	6.34	524	0.63	722.1	2.1	67.1	53.0	6.39	429	0.63	1.1	3.04	400	1401	1.1/.9	62.0	140.8	233	2587
3	119.1	79.4	6.95	828	0.75	722.8	2.5	88.3	53.0	7.33	647	0.83	1.8	3.04	400	2940	1.8/1.4	156.7	200.0	787	5202
3.5	161.3	86.0	7.77	1253	0.94	723.4	2.9	109.5	53.0	8.16	894	1.03	2.4	3.06	400	4550	2.4/1.8	236.7	200	1461	8158

ECI-4 PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI 1980 SHEET NO. 2 OF

EHRLICH LAKE DAM (MO. 10993) JOB NO. 1263

EMERGENCY SPILLWAY AND OVERTOP RATING CURVE BY RJD DATE 7/15/80

y_{c1}	A_1	T_1	$V_1=\left(\frac{A_1 g}{T_1}\right)^{1/2}$	$Q_1=V_1A_1$	$\frac{V_1^2}{2g}$	W.S ELEV. $y_{c1}+\frac{V_1^2}{2g}+719$	y_2	A_2	T_2	$V_2=\left(\frac{A_2 g}{T_2}\right)^{1/2}$	$Q_2=V_2A_2$	$\frac{V_2^2}{2g}$	H_3	C_3	L_3	$Q_3=C_3L_3H_3^{1.5}$	H_4/y_{c4}	A_4	T_4	$Q_4=\left(\frac{A_4^3 g}{T_4}\right)^{1/2}$	$Q_{TOTAL}=Q_1+Q_2+Q_3+Q_4$
4	204.3	86.0	8.74	1786	1.19	724.2	3.5	141.3	53.0	9.27	1310	1.33	3.2	3.08	400	7048	3.2/2.3	343.3	200	2553	12,697
5	290.3	86.0	10.42	3026	1.69	725.7	4.5	194.3	53.0	10.87	2112	1.83	4.7	3.10	400	12,647	4.7/3.3	543.3	200	5082	22,867
6	376.3	86.0	11.87	4466	2.19	727.2	5.5	247.3	53.0	12.26	3032	2.33	6.2	3.12	400	19,274	6.2/4.3	743.3	200	8132	34,904

AREA 3: H_3 = W.S. ELEV - 721

AREA 4: $H_4 = H_3$ = W.S. ELEV. - 721

For $y_{c4} < 1.25$; $y_{c4} = (4/5) H_4$; $A = (1/2) y_{c4} T$ where $T = 160 y_{c4}$

For $y_{c4} > 1.25$; $y_{c4} = 2/3 H_4 + 0.2083$; $A = 200 y_{c4} - 125$; $T = 200$ ft.

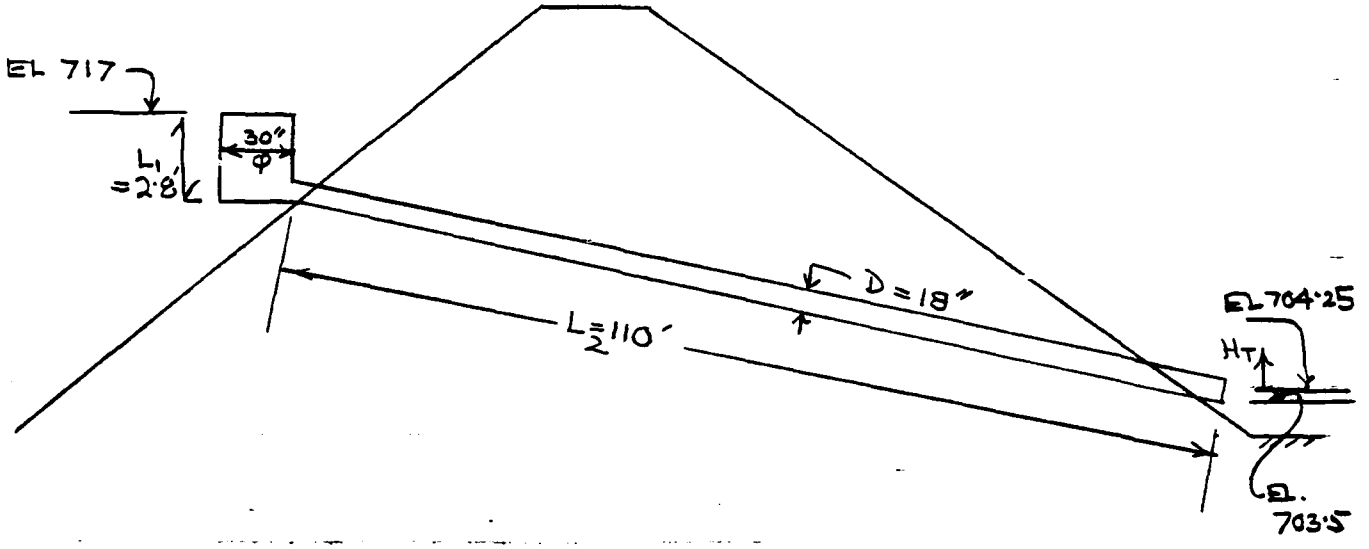
B-4

EC1-4 PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION/MISSOURI-1980 SHEET NO. 1 OF 3

EHRLICH LAKE DAM (MO. 10993) JOB NO. 1263

FLOW RATES THROUGH PRINCIPAL SPILLWAY BY MAG DATE 12/17/8



For Weir Flow: $Q_w = C_o (2\pi r) H_o^{3/2} = C_o (2\pi \times 1.25) H_o^{3/2}$

$= C_o (3.93) H_o^{3/2}$.

For Pipe Flow: $H_T = K_t \frac{V_t^2}{2g} + K_e \frac{V_1^2}{2g} + \frac{f_1 L_1}{D_1} \cdot \frac{V_1^2}{2g} + K_c \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g} \right)$

$+ \frac{f_2 L_2}{D_2} \cdot \frac{V_2^2}{2g} + K_{ex} \frac{V_2^2}{2g}$.

1) $K_t = 1.45 - 0.45 \frac{a_n}{a_g} - \left(\frac{a_n}{a_g} \right)^2$

Assume area of trash rack = 10% of the area of the standpipe

$\therefore K_t = 1.45 - .41 - .81 = 0.23$

2) K_e: Assume $K_e = 0.5$

3) f_1: Assume $f_1 = 0.027$

4) K_c: Assume $K_c = 0.5$

5) f_2: Assume $f_2 = 0.032$

6) $K_{ex} = 1.00$, and

$$V_t^2 = \left(\frac{1}{.9}\right)^2 V_1^2 = 1.24 V_1^2 = 1.24 \frac{A_2^2}{A_1^2} V_2^2 = 0.45 V_2^2$$

$$V_1^2 = \left(\frac{A_2}{A_1}\right)^2 V_2^2 = 0.36 V_2^2$$

$$\therefore H_T = (0.23)\frac{.45V_2^2}{2g} + (0.5)\frac{.36V_2^2}{2g} + \frac{.027 \times 2.8}{2.5}(.36)\frac{V_2^2}{2g}$$

$$+ 0.5\left(\frac{V_2^2}{2g} - .36\frac{V_2^2}{2g}\right) + \frac{.032 \times 110}{1.5} \cdot \frac{V_2^2}{2g} + \frac{V_2^2}{2g}$$

$$= (0.10 + .18 + .01 + 0.32 + 2.35 + 1)\frac{V_2^2}{2g}$$

$$= 3.96 \frac{V_2^2}{2g}.$$

$$\therefore V_2 = \sqrt{\frac{2g}{3.96}}\sqrt{H_T} = 4.03\sqrt{H_T}$$

$$Q_c = A_2 V_2 = 7.12\sqrt{H_T}$$

$$\therefore \underline{Q_c = 7.12\sqrt{H_T}}$$

EC1-4 PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION/MISSOURI-1980 SHEET NO. 3 OF 3

EHRLICH LAKE DAM (MO. 10993) JOB NO 1263

FLOW RATES THROUGH PRINCIPAL SPILLWAY BY MAS DATE 12/18/80

W.S. Elev.	H_o	$H_o^{3/2}$	C_o	$Q_w = 3.93 C_o H_o^{3/2}$	H_T	$Q_c = 7.12\sqrt{H_T}$
717	0	0				
718	1.0	1	3.33	13.0		
718.6	1.6	2.02	3.33	26.4	14.35	27.0
719.	2.0	2.83	3.33	37.0	14.75	27.3
719.33					15.08	27.7
719.6					15.35	27.9
720.5					16.25	28.7
720.9					16.65	29.1
721.5					17.25	29.6
722.1					17.85	30.1
722.8					18.55	30.7
723.4					19.15	31.2
724.2					19.95	31.8
725.7					21.45	33.0
727.2					22.95	34.1

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTIONS / MISSOURI 1980 SHEET NO. 1 OF 2
EHRLICH LAKE DAM (MO. 10993) JOB NO. 1263
COMBINED RATING CURVE BY RD DATE 7/21/82

PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, AND OVERTOP DISCHARGES

W.S. ELEV.	H_o or H_T	Q_1 PRINCIPAL SPILLWAY	Q_2 EMER. SPILLWAY AND OVERTOP	$Q_{TOTAL} = Q_1 + Q_2$
717.0	0	0	0	0
718.0	1.0	13	0	13
718.6	1.6 or 14.35	26	0	26
719.0	14.75	27	0	27
719.3	15.1	28	2	30
719.6	15.4	28	10	38
720.5	16.3	29	102	131
720.9	16.7	29	247	276
721.5	17.3	30	1002	1032
722.1	17.9	30	2587	2617
722.8	18.6	31	5202	5233
723.4	19.2	31	8158	8189
724.2	20.0	32	12,697	12,729
725.7	21.5	33	22,867	22,900
727.2	23.0	34	34,904	34,938

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF 1

DAM NAME: EHRLICH LAKE DAM / ID NO.: 10992 JOB NO. 1263

RESERVOIR ELEVATION - AREA DATA BY END DATE 7/15/80

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
703	0	Estimated upstream streambed
710	6.5	Planimetered - U.S.G.S. "Middletown, Mo." 7½ min.
717	18.5	Principal Spillway Crest
719	23.0	Right Emergency Spillway Crest
720	25.5	Planimetered - U.S.G.S. "Middletown, Mo." 7½ min
721	28.0	Top of Dam
730	64.0	Planimetered - U.S.G.S. "Middletown, Mo." 7½ min.

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 1

DAM NAME: EHRLICH LAKE DAM (MO. 10893) — JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS — BY BD DATE 7/15/80

1) DRAINAGE AREA, $A = 0.707$ sq. mi = (452.5 acres)

2) LENGTH OF STREAM, $L = (2.7'' \times 2000 = 5400') = 1.02$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 785$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 717$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 782$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 723$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10}) / 0.75L = (782-723)/0.75(5400)$

$= 0.0146$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = \left[(11.9 \times 1.02^3)/(785-717)\right]^{0.385} = 0.52 \text{ hr.}$$

B) BY VELOCITY ESTIMATE,

SLOPE = 1.46% ⇒ AVG. VELOCITY = 2 fps

$t_c = L/V = 5400/2 = 2700 \text{ s} = 0.75 \text{ hr.}$

USE $t_c = 0.52$ hr.

9) LAG TIME, $t_l = 0.6\, t_c = 0.6(0.52) = 0.31$ hr.

10) UNIT DURATION, $D \leq t_l/3 = 0.31/3 = 0.10$ ≤ 0.083 hr.

USE $D = 0.083$ hr = 5 min.

11) TIME TO PEAK, $T_p = D/2 + t_l = 0.083/2 + 0.31 = 0.35$ hr.

12) PEAK DISCHARGE,

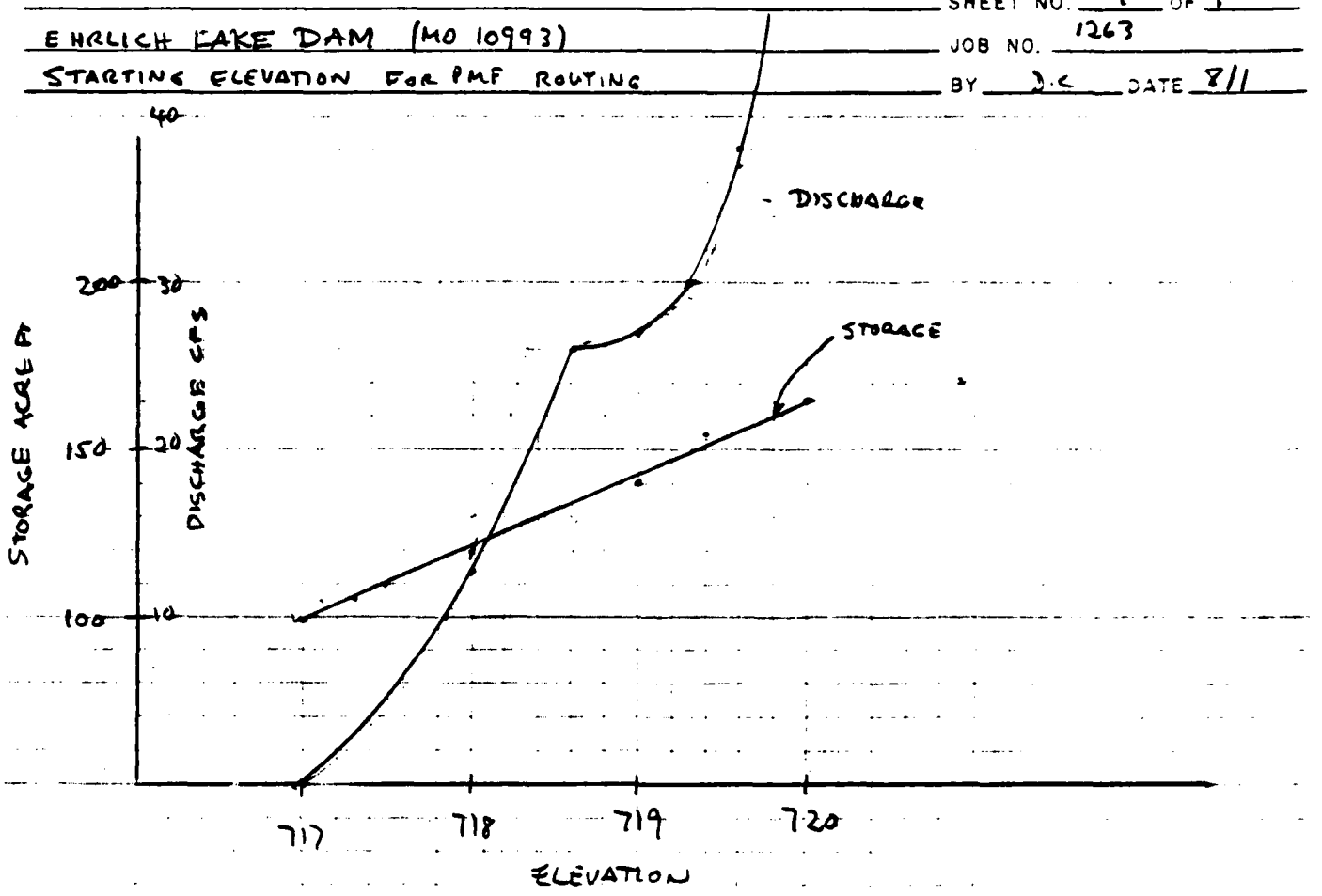
$$q_p = (484 \times A)/T_p = (484 \times 0.707)/0.35 = 978 \text{ cfs.}$$

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

SHEET NO. 1 OF 1

ENRLICH LAKE DAM (MO 10993) JOB NO. 1263

STARTING ELEVATION FOR PMF ROUTING BY J.C DATE 8/1



Elevat	Storage	Discharge	Δt	Σt
719.8	160	60	0	1
719.3	150	30	.11	1.11
718.3	126	26	.43	1.54
717.5	110	5	.52	2.06
717	99	0	2.22	4.28 ≃ Say 4 days

∴ Start PMF Routing at 717'

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************
    1                 A1                                DAM SAFETY INSPECTION - MISSOURI
    2                 A2                                  EHRLICK DAM LAKE (MO.10993)
    3                 A3                                     PMF AND 50 PERCENT PMF
    4                 B     300       0       5       0       0       0       0       0       0       0
    5                 J1      5
    6                 J       1       2       1
    7                 J1      1      .5
    8                 K       0   10993                                   1
    9                 R1    INPUT RUNOFF PARAMETERS
   10                 *       1       2   0.707           0.707       1                       1
   11                 *             24.7     100     120     130
   12                 T                                                       -1      -93
   13                 R2            0.31
   14                 *                     1
   15                 K       1   10993                                   1
   16                 R1    ROUTE HYDROGRAPH THROUGH EHRLICK DAM LAKE
   17                 *                                     1       1
   18                 Y1      1                                               -717      -1                -
   19                 Y4    717     718     718.6     719     719.3   719.6   720.5   720.9   721.5   722.1
   20                 Y4  722.8   723.4   724.2   725.7   727.2
   21                 Y5      0      13      26      27      30      36     131     276    1032    2617
   22                 Y5   5233    8189   12729   22900   34936
   23                 YA      0     6.5    18.5    23.0    25.5    28.0    64.0
   24                 YF    708     710     717     719     726     721     730
   25                 YI    717
   26                 YO    721
   27                 ZZ     99
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 80/12/02.
     TIME= 16.57.24.
```

DAM SAFETY INSPECTION - MISSOURI
EHNRICK DAM LAKE (NO.10993)
PMF AND 50 PERCENT PMF

JOB SPECIFICATION

NW	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT RUNOFF PARAMETERS

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
10993	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.71	0.00	.71	1.00	0.000	0	1	0

- PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.70	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-33.00	0.00	0.00

CURVE NO = -95.0 TAINESS = -1.00 EFFECT CN = 93.0%

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .31

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 21 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .31 VOL= 1.00

129.	916.	808.	567.	912.	737.	487.	325.	225.	152.
103.	70.	49.	35.	22.	15.	10.	8.	5.	3.

0.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.35	151	.21	.20	.00	976.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.21	.20	.00	1023.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.21	.20	.00	1051.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.21	.20	.00	1072.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.20	.00	1087.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.20	.00	1097.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.25	.25	.00	1109.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.25	.25	.00	1131.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.25	.25	.00	1168.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.25	.25	.00	1209.
1.01	.55	11	.01	.00	.01	0.	1.01	13.25	161	.25	.25	.00	1249.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.30	162	.25	.25	.00	1280.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.35	163	.25	.25	.00	1301.
1.01	1.10	14	.01	.00	.01	1.	1.01	13.40	164	.25	.25	.00	1315.
1.01	1.15	15	.01	.00	.01	2.	1.01	13.45	165	.25	.25	.00	1325.
1.01	1.20	16	.01	.00	.01	3.	1.01	13.50	166	.25	.25	.00	1331.
1.01	1.25	17	.01	.00	.01	4.	1.01	13.55	167	.25	.25	.00	1336.
1.01	1.30	18	.01	.00	.01	5.	1.01	14.00	168	.25	.25	.00	1339.
1.01	1.35	19	.01	.00	.01	7.	1.01	14.05	169	.31	.31	.00	1349.
1.01	1.40	20	.01	.00	.01	10.	1.01	14.10	170	.31	.31	.00	1376.
1.01	1.45	21	.01	.00	.01	12.	1.01	14.15	171	.31	.31	.00	1427.
1.01	1.50	22	.01	.00	.01	14.	1.01	14.20	172	.31	.31	.00	1488.
1.01	1.55	23	.01	.00	.01	16.	1.01	14.25	173	.31	.31	.00	1545.
1.01	2.00	24	.01	.00	.01	18.	1.01	14.30	174	.31	.31	.00	1590.
1.01	2.05	25	.01	.00	.01	20.	1.01	14.35	175	.31	.31	.00	1621.
1.01	2.10	26	.01	.00	.01	21.	1.01	14.40	176	.31	.31	.00	1641.
1.01	2.15	27	.01	.00	.01	22.	1.01	14.45	177	.31	.31	.00	1655.
1.01	2.20	28	.01	.00	.01	24.	1.01	14.50	178	.31	.31	.00	1665.
1.01	2.25	29	.01	.00	.01	25.	1.01	14.55	179	.31	.31	.00	1671.
1.01	2.30	30	.01	.00	.01	27.	1.01	15.00	180	.31	.31	.00	1676.
1.01	2.35	31	.01	.00	.01	29.	1.01	15.05	181	.19	.19	.00	1663.
1.01	2.40	32	.01	.00	.01	30.	1.01	15.10	182	.38	.37	.00	1640.
1.01	2.45	33	.01	.00	.01	31.	1.01	15.15	183	.38	.37	.00	1621.
1.01	2.50	34	.01	.00	.01	33.	1.01	15.20	184	.56	.56	.00	1682.
1.01	2.55	35	.01	.00	.01	34.	1.01	15.25	185	.66	.66	.00	1942.
1.01	3.00	36	.01	.00	.01	35.	1.01	15.30	186	1.60	1.59	.00	2238.
1.01	3.05	37	.01	.00	.01	36.	1.01	15.35	187	2.63	2.62	.00	3099.
1.01	3.10	38	.01	.00	.01	37.	1.01	15.40	188	1.03	1.03	.00	4392.
1.01	3.15	39	.01	.00	.01	38.	1.01	15.45	189	.66	.66	.00	5677.
1.01	3.20	40	.01	.00	.01	39.	1.01	15.50	190	.56	.56	.00	6258.
1.01	3.25	41	.01	.00	.01	40.	1.01	15.55	191	.38	.38	.00	6105.
1.01	3.30	42	.01	.00	.01	40.	1.01	16.00	192	.38	.38	.00	5435.
1.01	3.35	43	.01	.00	.01	41.	1.01	16.05	193	.29	.29	.00	4528.
1.01	3.40	44	.01	.00	.01	42.	1.01	16.10	194	.29	.29	.00	3755.
1.01	3.45	45	.01	.00	.01	43.	1.01	16.15	195	.29	.29	.00	3148.
1.01	3.50	46	.01	.00	.01	44.	1.01	16.20	196	.29	.29	.00	2671.
1.01	3.55	47	.01	.00	.01	44.	1.01	16.25	197	.29	.29	.00	2328.
1.01	4.00	48	.01	.00	.00	45.	1.01	16.30	198	.29	.29	.00	2036.
1.01	4.05	49	.01	.00	.00	46.	1.01	16.35	199	.29	.29	.00	1922.
1.01	4.10	50	.01	.00	.00	46.	1.01	16.40	200	.29	.29	.00	1812.
1.01	4.15	51	.01	.00	.00	47.	1.01	16.45	201	.29	.29	.00	1736.
1.01	4.20	52	.01	.00	.00	48.	1.01	16.50	202	.29	.29	.00	1685.
1.01	4.25	53	.01	.00	.00	48.	1.01	16.55	203	.29	.29	.00	1651.
1.01	4.30	54	.01	.00	.00	49.	1.01	17.00	204	.29	.29	.00	1627.
1.01	4.35	55	.01	.00	.00	49.	1.01	17.05	205	.23	.23	.00	1601.

1.01	4.40	56	.01	.01	.00	50.	1.01	17.10	206	.23	.23	.00	1561.
1.01	4.45	57	.01	.01	.00	50.	1.01	17.15	207	.23	.23	.00	1501.
1.01	4.50	58	.01	.01	.00	51.	1.01	17.20	208	.23	.23	.00	1437.
1.01	4.55	59	.01	.01	.00	51.	1.01	17.25	209	.23	.23	.00	1378.
1.01	5.00	60	.01	.01	.00	52.	1.01	17.30	210	.23	.23	.00	1332.
1.01	5.05	61	.01	.01	.00	52.	1.01	17.35	211	.23	.23	.00	1301.
1.01	5.10	62	.01	.01	.00	53.	1.01	17.40	212	.23	.23	.00	1281.
1.01	5.15	63	.01	.01	.00	53.	1.01	17.45	213	.23	.23	.00	1267.
1.01	5.20	64	.01	.01	.00	54.	1.01	17.50	214	.23	.23	.00	1258.
1.01	5.25	65	.01	.01	.00	54.	1.01	17.55	215	.23	.23	.00	1251.
1.01	5.30	66	.01	.01	.00	55.	1.01	18.00	216	.23	.23	.00	1247.
1.01	5.35	67	.01	.01	.00	55.	1.01	18.05	217	.02	.02	.00	1217.
1.01	5.40	68	.01	.01	.00	55.	1.01	18.10	218	.02	.02	.00	1130.
1.01	5.45	69	.01	.01	.00	56.	1.01	18.15	219	.02	.02	.00	962.
1.01	5.50	70	.01	.01	.00	56.	1.01	18.20	220	.02	.02	.00	762.
1.01	5.55	71	.01	.01	.00	56.	1.01	18.25	221	.02	.02	.00	574.
1.01	6.00	72	.01	.01	.00	57.	1.01	18.30	222	.02	.02	.00	422.
1.01	6.05	73	.07	.06	.01	61.	1.01	18.35	223	.02	.02	.00	322.
1.01	6.10	74	.07	.06	.01	81.	1.01	18.40	224	.02	.02	.00	255.
1.01	6.15	75	.07	.06	.01	117.	1.01	18.45	225	.02	.02	.00	209.
1.01	6.20	76	.07	.06	.01	160.	1.01	18.50	226	.02	.02	.00	178.
1.01	6.25	77	.07	.06	.01	209.	1.01	18.55	227	.02	.02	.00	156.
1.01	6.30	78	.07	.06	.01	254.	1.01	19.00	228	.02	.02	.00	142.
1.01	6.35	79	.07	.06	.01	285.	1.01	19.05	229	.02	.02	.00	132.
1.01	6.40	80	.07	.06	.01	289.	1.01	19.10	230	.02	.02	.00	125.
1.01	6.45	81	.07	.06	.01	284.	1.01	19.15	231	.02	.02	.00	121.
1.01	6.50	82	.07	.06	.01	304.	1.01	19.20	232	.02	.02	.00	118.
1.01	6.55	83	.07	.06	.01	312.	1.01	19.25	233	.02	.02	.00	116.
1.01	7.00	84	.07	.06	.01	319.	1.01	19.30	234	.02	.02	.00	114.
1.01	7.05	85	.07	.06	.01	324.	1.01	19.35	235	.02	.02	.00	113.
1.01	7.10	86	.07	.06	.01	328.	1.01	19.40	236	.02	.02	.00	113.
1.01	7.15	87	.07	.06	.01	332.	1.01	19.45	237	.02	.02	.00	113.
1.01	7.20	88	.07	.06	.01	335.	1.01	19.50	238	.02	.02	.00	113.
1.01	7.25	89	.07	.06	.01	338.	1.01	19.55	239	.02	.02	.00	113.
1.01	7.30	90	.07	.06	.00	340.	1.01	20.00	240	.02	.02	.00	113.
1.01	7.35	91	.07	.06	.00	342.	1.01	20.05	241	.02	.02	.00	113.
1.01	7.40	92	.07	.06	.00	344.	1.01	20.10	242	.02	.02	.00	113.
1.01	7.45	93	.07	.06	.00	346.	1.01	20.15	243	.02	.02	.00	113.
1.01	7.50	94	.07	.06	.00	347.	1.01	20.20	244	.02	.02	.00	113.
1.01	7.55	95	.07	.06	.00	348.	1.01	20.25	245	.02	.02	.00	113.
1.01	8.00	96	.07	.06	.00	350.	1.01	20.30	246	.02	.02	.00	113.
1.01	8.05	97	.07	.06	.00	351.	1.01	20.35	247	.02	.02	.00	113.
1.01	8.10	98	.07	.07	.00	352.	1.01	20.40	248	.02	.02	.00	113.
1.01	8.15	99	.07	.07	.00	353.	1.01	20.45	249	.02	.02	.00	113.
1.01	8.20	100	.07	.07	.00	354.	1.01	20.50	250	.02	.02	.00	113.
1.01	8.25	101	.07	.07	.00	355.	1.01	20.55	251	.02	.02	.00	113.
1.01	8.30	102	.07	.07	.00	356.	1.01	21.00	252	.02	.02	.00	113.
1.01	8.35	103	.07	.07	.00	357.	1.01	21.05	253	.02	.02	.00	113.
1.01	8.40	104	.07	.07	.00	357.	1.01	21.10	254	.02	.02	.00	113.
1.01	8.45	105	.07	.07	.00	358.	1.01	21.15	255	.02	.02	.00	113.
1.01	8.50	106	.07	.07	.00	359.	1.01	21.20	256	.02	.02	.00	113.
1.01	8.55	107	.07	.07	.00	359.	1.01	21.25	257	.02	.02	.00	113.
1.01	9.00	108	.07	.07	.00	360.	1.01	21.30	258	.02	.02	.00	113.
1.01	9.05	109	.07	.07	.00	361.	1.01	21.35	259	.02	.02	.00	113.
1.01	9.10	110	.07	.07	.00	361.	1.01	21.40	260	.02	.02	.00	113.
1.01	9.15	111	.07	.07	.00	362.	1.01	21.45	261	.02	.02	.00	113.
1.01	9.20	112	.07	.07	.00	362.	1.01	21.50	262	.02	.02	.00	113.
1.01	9.25	113	.07	.07	.00	362.	1.01	21.55	263	.02	.02	.00	113.
1.01	9.30	114	.07	.07	.00	363.	1.01	22.00	264	.02	.02	.00	113.
1.01	9.35	115	.07	.07	.00	363.	1.01	22.05	265	.02	.02	.00	113.

1.01	9.40	116	.07	.07	.00	364.	1.01	22.10	266	.02	.02	.00	113.
1.01	9.45	117	.07	.07	.00	364.	1.01	22.15	267	.02	.02	.00	113.
1.01	9.50	118	.07	.07	.00	364.	1.01	22.20	268	.02	.02	.00	113.
1.01	9.55	119	.07	.07	.00	365.	1.01	22.25	269	.02	.02	.00	113.
1.01	10.00	120	.07	.07	.00	365.	1.01	22.30	270	.02	.02	.00	113.
1.01	10.05	121	.07	.07	.00	365.	1.01	22.35	271	.02	.02	.00	113.
1.01	10.10	122	.07	.07	.00	366.	1.01	22.40	272	.02	.02	.00	113.
1.01	10.15	123	.07	.07	.00	366.	1.01	22.45	273	.02	.02	.00	113.
1.01	10.20	124	.07	.07	.00	366.	1.01	22.50	274	.02	.02	.00	113.
1.01	10.25	125	.07	.07	.00	366.	1.01	22.55	275	.02	.02	.00	113.
1.01	10.30	126	.07	.07	.00	367.	1.01	23.00	276	.02	.02	.00	113.
1.01	10.35	127	.07	.07	.00	367.	1.01	23.05	277	.02	.02	.00	113.
1.01	10.40	128	.07	.07	.00	367.	1.01	23.10	278	.02	.02	.00	113.
1.01	10.45	129	.07	.07	.00	367.	1.01	23.15	279	.02	.02	.00	113.
1.01	10.50	130	.07	.07	.00	368.	1.01	23.20	280	.02	.02	.00	113.
1.01	10.55	131	.07	.07	.00	368.	1.01	23.25	281	.02	.02	.00	113.
1.01	11.00	132	.07	.07	.00	368.	1.01	23.30	282	.02	.02	.00	113.
1.01	11.05	133	.07	.07	.00	368.	1.01	23.35	283	.02	.02	.00	113.
1.01	11.10	134	.07	.07	.00	368.	1.01	23.40	284	.02	.02	.00	113.
1.01	11.15	135	.07	.07	.00	369.	1.01	23.45	285	.02	.02	.00	113.
1.01	11.20	136	.07	.07	.00	369.	1.01	23.50	286	.02	.02	.00	113.
1.01	11.25	137	.07	.07	.00	369.	1.01	23.55	287	.02	.02	.00	113.
1.01	11.30	138	.07	.07	.00	369.	1.02	0.00	288	.02	.02	.00	113.
1.01	11.35	139	.07	.07	.00	369.	1.02	.05	289	0.00	0.00	0.00	110.
1.01	11.40	140	.07	.07	.00	369.	1.02	.10	290	0.00	0.00	0.00	101.
1.01	11.45	141	.07	.07	.00	369.	1.02	.15	291	0.00	0.00	0.00	85.
1.01	11.50	142	.07	.07	.00	370.	1.02	.20	292	0.00	0.00	0.00	65.
1.01	11.55	143	.07	.07	.00	370.	1.02	.25	293	0.00	0.00	0.00	46.
1.01	12.00	144	.07	.07	.00	370.	1.02	.30	294	0.00	0.00	0.00	31.
1.01	12.05	145	.21	.20	.00	388.	1.02	.35	295	0.00	0.00	0.00	21.
1.01	12.10	146	.21	.20	.00	444.	1.02	.40	296	0.00	0.00	0.00	14.
1.01	12.15	147	.21	.20	.00	554.	1.02	.45	297	0.00	0.00	0.00	10.
1.01	12.20	148	.21	.20	.00	685.	1.02	.50	298	0.00	0.00	0.00	6.
1.01	12.25	149	.21	.20	.00	805.	1.02	.55	299	0.00	0.00	0.00	4.
1.01	12.30	150	.21	.20	.00	909.	1.02	1.00	300	0.00	0.00	0.00	3.
									SUM	32.11	31.22	.89	170880.
										(816.)(	793.)(	23.)(	483%.78)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5254.	1381.	545.	570.	170857.
C.S	177.	47.	17.	16.	4838.
INCHES		24.28	31.22	31.22	31.22
MM		616.73	793.06	793.06	793.06
AC-FT		915.	1177.	1177.	1177.
THOUS CU M		1129.	1451.	1451.	1451.

HYDROGRAPH AT STA 10993 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	2.	3.	4.	6.	8.	10.
12.	14.	16.	18.	20.	21.	23.	24.	26.	27.
29.	30.	31.	32.	34.	35.	36.	37.	38.	39.
40.	40.	41.	42.	43.	44.	44.	45.	46.	46.
47.	48.	48.	49.	49.	50.	50.	51.	51.	52.
52.	53.	53.	54.	54.	55.	55.	56.	56.	56.
56.	57.	63.	81.	117.	160.	202.	238.	263.	280.
294.	304.	312.	319.	324.	328.	332.	335.	338.	340.
342.	344.	346.	347.	348.	350.	351.	352.	353.	354.

355.	356.	357.	357.	358.	359.	359.	360.	361.	361.
362.	362.	362.	363.	363.	364.	364.	364.	365.	365.
365.	366.	366.	366.	366.	367.	367.	367.	367.	368.
368.	368.	368.	368.	369.	369.	369.	369.	369.	369.
369.	370.	370.	370.	388.	444.	554.	685.	809.	909.
976.	1020.	1051.	1072.	1087.	1097.	1109.	1131.	1168.	1209.
1249.	1280.	1301.	1316.	1325.	1331.	1336.	1339.	1349.	1376.
1427.	1489.	1545.	1590.	1621.	1641.	1655.	1665.	1671.	1676.
1663.	1640.	1621.	1682.	1843.	2238.	3098.	4392.	5677.	6258.
6105.	5435.	4528.	3755.	3148.	2671.	2328.	2086.	1922.	1812.
1736.	1685.	1641.	1627.	1601.	1561.	1501.	1437.	1378.	1332.
1301.	1281.	1267.	1258.	1251.	1247.	1217.	1130.	962.	762.
574.	422.	322.	255.	209.	178.	156.	142.	132.	125.
121.	118.	116.	114.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.	110.	101.
85.	65.	46.	31.	21.	14.	10.	6.	4.	3.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6256.	1645.	595.	570.	170857.
CMS	177.	52.	17.	16.	4838.
INCHES		24.38	31.22	31.22	31.22
MM		616.77	793.06	793.06	793.06
AC-FT		915.	1177.	1177.	1177.
THOUS CU M		1129.	1451.	1451.	1451.

HYDROGRAPH AT STA 10993 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	2.	3.	4.	5.
6.	7.	8.	9.	10.	11.	11.	12.	13.	14.
14.	15.	15.	16.	17.	17.	18.	18.	19.	19.
20.	20.	21.	21.	21.	22.	22.	23.	23.	23.
24.	24.	24.	24.	25.	25.	25.	25.	26.	26.
26.	26.	27.	27.	27.	27.	27.	28.	28.	28.
28.	28.	31.	41.	58.	80.	101.	119.	131.	140.
147.	152.	156.	159.	162.	164.	166.	167.	169.	170.
171.	172.	173.	174.	174.	175.	175.	176.	177.	177.
177.	178.	178.	179.	179.	179.	180.	180.	180.	181.
181.	181.	181.	181.	182.	182.	182.	182.	182.	183.
183.	183.	183.	183.	183.	183.	183.	184.	184.	184.
184.	184.	184.	184.	184.	184.	184.	185.	185.	185.
185.	185.	185.	185.	194.	212.	277.	342.	404.	455.
498.	530.	552.	566.	576.	583.	588.	595.	596.	605.
624.	640.	651.	658.	662.	666.	668.	670.	675.	688.
714.	744.	772.	795.	810.	821.	828.	832.	836.	838.
832.	820.	811.	841.	922.	1119.	1549.	2196.	2839.	3129.
3053.	2717.	2264.	1878.	1574.	1335.	1164.	1043.	961.	906.
868.	842.	825.	813.	800.	780.	750.	718.	689.	666.
651.	640.	634.	629.	626.	614.	603.	565.	481.	381.
287.	211.	161.	128.	104.	89.	78.	71.	66.	63.
60.	59.	58.	57.	57.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.

56.	56.	56.	56.	56.	56.	56.	56.	55.	51.
42.	32.	23.	16.	10.	7.	5.	3.	2.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3129.	923.	297.	285.	85429.
CMS	89.	26.	8.	8.	2419.
INCHES		12.14	15.61	15.61	15.61
MM		308.36	396.53	396.53	396.53
AC-FT		458.	589.	588.	588.
THOUS CU M		564.	726.	726.	726.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH ERLICK DAM LAKE

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
16995	1	0	0	0	0	1	0	0

ROUTING DATA

qLOSS	CLOSS	AVG	IRES	ISAME	ICON	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.200	1.000	-717.	-1

STAGE	717.0	718.00	718.60	719.00	719.30	719.60	720.50	720.90	721.50	722.10
	723.00	723.40	724.23	725.70	727.20					
FLOW	0.0.	13.00	26.00	27.00	30.00	39.00	131.00	276.00	1032.00	2617.00
	5043.00	7189.00	12729.00	22900.00	59338.00					

SURFACE AREA=	0.	7.	19.	23.	26.	28.	64.
CAPACITY=	0.	13.	99.	141.	165.	191.	594.
ELEVATION=	705.	710.	717.	719.	720.	721.	730.

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
717.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
721.0	3.0	0.0	0.

STATION 16995, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	2.	2.	2.	2.	2.	3.	3.
3.	3.	3.	3.	3.	4.	4.	4.	4.	4.
5.	5.	5.	5.	5.	6.	6.	6.	6.	6.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	10994	.71	1	6258.	3129.
		(1.83)		(177.20)	(88.60)
ROUTED TO	10994	.71	1	5622.	2820.
		(1.83)		(164.85)	(79.85)

B-19

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	717.00	717.00	721.00
STORAGE	99.	99.	191.
OUTFLOW	0.	0.	402.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	722.92	1.92	251.	5622.	6.67	15.92	0.00
.50	722.15	1.15	226.	2420.	5.42	16.00	0.00

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  26 FEB 79
**********************************
A1                        DAM SAFETY INSPECTION - MISSOURI
A2                          EHRLICK DAM LAKE (MO.10993)
A3                                   PERCENT PMF
B    300      0      5      0      0      0      0      0     -4      0
B1     5
J      1      4      1
J1   .12    .13    .14    .15
K      0  10993                                    1
K1   INPUT RUNOFF PARAMETERS
M      1      2  0.707         0.707      1                   1
P          24.7    100    120    130
T
W2         0.31                               -1    -93
X                    1
K      1  10993                                    1
K1   ROUTE HYDROGRAPH THROUGH EHRLICK DAM LAKE
Y                           1      1
Y1     1
Y4   717    718  718.6    719  719.3  719.6  720.5  720.9  721.5  722.1
Y4 722.8  723.4  724.2  725.7  727.2
Y5     0     13     26     27     30     38    131    276   1032   2617
Y5  5233   8169  12729  22900  34938
$A     0    6.5   18.5   23.0   25.5   28.0   64.0
$E   703    710    717    719    720    721    730
$S   717
$D   721
K     99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80/12/22.
TIME= 17.40.34.

DAM SAFETY INSPECTION - MISSOURI
EHRLICH DAM LAKE (MO.10993)
PERCENT PMF

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	-4	0

JOPCN	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .12 .13 .14 .15

****

SUB-AREA RUNOFF COMPUTATION

INPUT RUNOFF PARAMETERS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
10993	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.71	0.00	.71	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.70	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-95.00	0.00	0.00

CURVE NO = -95.00 WETNESS = -1.00 EFFECT CN = 95.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .31

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 32.11 31.22 .89 176880.
(816.) (793.) (23.) (4838.78)

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH FAHLICK DAM LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
10993	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	ICPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-717.	-1

STAGE	717.00	718.00	719.60	719.00	719.30	719.60	720.50	720.90	721.50	722.10
	722.90	723.40	724.20	725.70	727.20					
FLOW	0.00	13.00	26.00	27.00	30.00	34.00	151.00	276.00	1032.00	2617.00
	5235.00	8189.00	12729.00	22961.00	34938.00					
SURFACE AREA=	0.	7.	19.	25.	26.	28.	64.			
CAPACITY=	0.	1%.	59.	141.	165.	191.	594.			
ELEVATION=	703.	710.	717.	719.	720.	721.	730.			

CREL	SPWID	COQW	EXPW	FLEVL	COQL	CAREA	EXPL
717.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
721.0	0.0	1.0	0.

PEAK OUTFLOW IS 225. AT TIME 16.50 HOURS

PEAK OUTFLOW IS 286. AT TIME 16.50 HOURS

PEAK OUTFLOW IS 405. AT TIME 16.33 HOURS

PEAK OUTFLOW IS 510. AT TIME 16.25 HOURS

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS			
				RATIO 1 .12	RATIO 2 .13	RATIO 3 .14	RATIO 4 .15
HYDROGRAPH AT	10995	.71	1	751.	814.	876.	939.
		(1.83)		(21.26)(	23.04)(	24.81)(	26.58)(
ROUTED TO	10995	.71	1	225.	286.	405.	510.
		(1.83)		(6.37)(	8.09)(	11.47)(	14.44)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	717.00	717.00	721.00
STORAGE	99.	99.	191.
OUTFLOW	0.	0.	402.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.12	720.76	0.00	185.	325.	0.00	16.58	0.00
.13	721.91	0.00	189.	386.	0.00	16.50	0.00
.14	721.00	.00	192.	405.	.17	16.33	0.00
.15	721.09	.09	194.	510.	.50	16.25	0.00